Science Education

AN EXPERIMENT WITH RECORDED SCIENCE LESSONS *

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The Committee on Scientific Aids to Learning of the National Research Council, of which Dr. Irvin Stewart is Director, proposed the problem to determine to what extent, if any, science recordings may be an aid to the teaching of science. Because of my experience in preparing science scripts and broadcasting science lessons for seventh-grade children over the Rochester School of the Air for the past half dozen years, I was asked to write the scripts for forty science lessons and make the recordings.

Each science lesson is ten minutes long, five minutes on each side of the record. Each lesson is introduced by a musical theme. At the close of the first five minutes of each record, that is, the first side, suggestions are made for pupil follow-up work. The second side of the record continues the discussion pertinent to the problems under investigation, and gives further directions for follow-up work. On the records, in addition to motivating devices, content development, et cetera, are directions to pupils for carrying out the various science experiments in school, at home, and out of doors.

As has been my plan on the radio, each class listening to the records was advised to organize as a science club with the following officers: Director (the teacher); Chief of Staff and Assistant; Chief Observer and Assistants for Weather, Astronomy, Birds, Plants, and Geology; Chief of Scientific Methods; Chief Health Officer; and Chief of Records. The purpose of the club and its officers was to establish each class as a working unit with individuals selected by the pupils to be responsible for various activities. The Chief of Records was invited to report to me each week on the work of his class. Other officers were also asked to report occasionally in regard to their special duties.

As a result of this invitation for correspondence, nearly fifteen hundred letters were received from pupils and teachers. All of this correspondence was answered and was analyzed for pertinent comments. Questions raised by pupils and teachers were answered to the best of our ability.

As a result of this exchange of letters, there grew up a genuine feeling of acquaintanceship between the pupils and the "voice" on the record. One teacher wrote as follows:

"I think my pupils know you better than they know me."

Another wrote:

"You see, you are more than a record to my pupils."

It may be of interest to call attention to the fact that the children formed images of the speaker from the voice, which indicates that the voice from the record does represent a person with size, eyes, and hair color, age, and various personal characteristics. In fact, several children wrote and asked for my photograph in order that they could see what I looked like. I told them that I would send the picture if they would first send me what they thought I looked like. From these letters it appears that the voice is that of a person approximately five feet eight inches tall, forty-five years of age, and with a jolly personality. I leave you to judge the accuracy of this description. As a matter of fact, the children in

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my radio classes have frequently stated that they thought I was tall. I appear to have a "tall voice." I hope my science stories are not "tall stories."

In order to direct their thinking the pupils were asked to discuss the material on each record, not only from the standpoint of the solution of problems presented but, also, to determine what they found most interesting, and what they thought was most important. Their attention was called, too, to the fact that very likely questions would arise which they themselves could not answer. In their letters the children advised me as to the interesting and important thing in each lesson, and presented questions on which they wished help. These statements and questions were carefully studied and data tabulated showing the interests of the seventh-grade boys and girls for whom the records were designed.

Perhaps a few extracts from letters sent in by children may be of interest at this point. For example, one boy, Jimmy Scott, wrote me at the beginning of the experiment:

"Perhaps I had better introduce myself before going on with the rest of my letter. I am Jimmy Scott, the Chief of Records in the seventh class of the Berlin A School. I intend to keep you informed of what we are doing from week to week.

"Every one in my class seems to enjoy your classes immensely. In my opinion, even though I have always liked science, I enjoy science better than ever.

"Last week you introduced yourself. Every one was so quiet you could have heard a mouse sneeze. So you see, we were very interested.

"I have never made a friend without meeting him or her personally, so you see this is a new and interesting experience."

Jimmy also refers to an experiment they had tried to learn the need of oxygen for combustion. He adds this postcript to his letter:

"When the flame burned the oxygen in the jar and turned it into carbon dioxide. Why did the water rise? Is oxygen heavier than carbon dioxide?"

This letter, of course, was answered in some detail and the question discussed in such a way that the children could find their own answer.

One week later Jimmy wrote again, and said:

"How time does fly. We have made quite a little progress in science this week."

Another letter from Jimmy says:

"Before I tell you of our science progress this week, I shall tell you of myself. I live on a farm two miles south of Berlin. Have you ever lived on one? During the summer I am busy helping cultivate, plow, etc.

"Attempting to describe myself is a difficult job, because I don't think the mirror reflects correctly. Anyway, I am four feet nine inches tall. Some people say I am fat, but I don't think so. Riding is my favorite sport. I have a pony in which I take great pride. He and I are great pals."

Later in this letter Jimmy says:

"The members of my class have written a paragraph on 'Some results of the fact that air dissolves in water.' You will be sent some of these.

"The observers are on their tip toes. For instance, the Observer of the Heavens has drawn several charts showing the positions of certain constellations. They have been displayed on the bulletin board."

After discussing work of other observers, he states:

"We wish to ask, why do the gases of the air always remain the same, that is 78% nitrogen and 21% oxygen, etc.?"

Of course, this letter, like all the others, was answered in a personal way. I could go on giving still more extracts from a series of letters from Jimmy Scott, as I could from many, many other children. However, these will suffice to indicate the character of the correspondence. On the other hand, I would like to refer to another letter written by Jimmy on May 17, near the end of the course in which he says,

"When I think that I am writing my last report to you, I become very sad. You probably can't realize how much we have appreciated your course."

Jimmy proved to be a very systematic youngster, and in this "last letter" he says,

"Here are several reasons why I enjoyed your course:

1. Taking a course by record is so unusual, I became curious to find out what it was about, thereby becoming interested in it.
2. Having experiments performed before my eyes made lasting impressions.
3. Writing weekly reports clinched the facts I learned.
4. Being able to ask you questions I didn't understand caused me to have great confidence in you.

"I intend to continue my science work through high school and college. You will probably hear from me again, but in case you don't, I wish to very reluctantly say good-bye.

Jimmy Scott"

Elsie Tull writes,

"Never before have I enjoyed science as well as I have this year. The gases of the air are very interesting. I think every one should know the structure of the atmosphere about them. All people should know how to prevent oxidation in their homes. Since we have taken the unit on respiration in science, I can notice better posture habits on the part of the pupils. Fire is one of the most interesting units I have ever taken in school. Every one has learned to be more careful. We have also learned more rules of fire prevention."

Helen Mumper says:

"This study of science has added much to my knowledge of many subjects. In high school I intend to take up biology, chemistry, and physics, which I know I will like intensely.

"I hope this work will be continued for some years as it will help hundreds of students as it did me."

The following is a letter from Alice Yeager. The questions answered are implied, I think, by the answer. Here's what she says:

"Here are the answers to your questions. The first is yes, we do give reasons for our statements. The second is yes, we do change our minds when new facts are produced. The third is yes, too, because we do believe in a cause, and we don't believe that something happens without a cause."

Space will not permit me more quotations from pupils. The following are a few comments sent in by teachers:

(1) "One of my slowest pupils made the score of twenty on the test. He told me that he got a great deal more by listening to the records than he could by reading."

(2) "I have never been able to create very much interest in the seventh grade before using your records, but I find the interest and the attitude of these children very good."

(3) "The science project has become the center of interest from which so many things grow, that I believe it would be almost impossible to report to you upon all of them."

(4) "I am sending in some statements from pupils to indicate their interest. Some of these follow:

1. 'Goodness, this was a short period.'
2. 'I made a terrarium last night. I got my plants and moss from the woods and mother helped me to place them in the large jar.'
3. 'I saw three interesting black and white birds this morning. My mother says she thinks they are sea birds.'
4. 'I finished my birdhouse last night.'
5. 'I had fun proving that air had weight and exerted pressure.'
6. 'My mother believed the yolk instead of the white of the egg made the silver spoon tarnish.'"

The quotations given above are representative of the great majority of comments. On the other hand there were some adverse comments. For example, some teachers felt that the use of the records resulted in too fixed a course. Some felt that the problems proposed did not leave time enough to develop the interest of the pupil, or to train the pupils in skills necessary to get the most out of the course. Some thought there was not enough time to train the pupil in note-taking, to develop scientific thinking, or for the observers to do their work really well. Some few pupils wrote in that they were not particularly interested in science, and that they became bored listening to the records after a time. Nevertheless, adverse comments were relatively few and far between.

A number of teachers in one state who had used the records had conferences regarding their value, and among other things they report as follows:

1. "The group agreed that the recorded lessons presented by Mr. Carpenter served as a good consultant-teacher-plan for schools in rural areas of small communities. The teachers agreed that a carefully conducted program of this kind is excellent in-service training for teachers, and that science is one of the important fields where training in service is needed.

2. "There is evidence from the discussion that these lessons have been important in formulating

a guiding philosophy for teachers and a clear vision of specific goals in the teaching of science. There is also evidence that it is helping them plan from large concepts.

3. "The group was favorably impressed with the enthusiasm, interest, and naturalness of the children in the group they observed.

4. "The teachers participating in the experiment were very enthusiastic, and each felt that they had grown in method and technique, and had developed a new set of values for the teaching of science.

5. "Children have taken over some of the responsibility of experiments, observations, and research. They spontaneously talk of things they do and see, experiments they have performed at home and in free time.

6. "Slow children have shown unusual interest in science throughout this experiment."

Each cooperating teacher received not only the records, but also nearly seventy pages of bulletin service which were written week by week, unit tests, and summarized data relating to the unit tests. The bulletins contained brief comments concerning the science program, answered questions raised by teachers which appeared to have general significance, and pointed out certain objectives of science teaching which the recorded material was designed to develop.

In order to determine to what extent, if any, the science interests of the children changed during the period of the test, a science interest test was given at the beginning of the experiment and repeated at the end of the semester. Also a final achievement test was given to each child. Data from these tests, and from the unit tests, were summarized. They will be referred to later in this article.

The records were listened to by approximately eleven thousand children sitting in three hundred seven classes in fourteen states. The number of teachers involved were in excess of one hundred seventy-one. The number of cities and towns in which the records were used was one hundred thirty-six. Results of the experiment, therefore, represent a wide distribution of children from Massachusetts and New York State, to North and South Carolina, Texas, New Mexico, Nevada, and Minnesota.

The topics presented on the records had to do with the units on air and fire, and short units on safety education, vacation hazards, and forests.

It should be pointed out that with the exception of the classes in Rochester, data for which have not yet been completed, no attempt was made to set up control classes. Rather was it felt that the purpose of this experiment would be served by summarizing the various factors which have been discussed in the report to the Committee on Scientific Aids to Learning, under the following headings:

1. Contributing Factors. In this section is presented information regarding voice reproduction, kind of phonograph used, interest and activities of children, training and experience of teachers, laboratory equipment, textbook and library facilities, note-taking by pupils, number of times a record was played, and similar information. These factors were studied and summarized because they were thought to have a definite bearing upon the problem to determine to what extent, if any, recorded sound may serve as an aid to the teaching of science in the seventh grade.

Under the heading Results, are submitted opinions and comments by teachers and supervisors, quoted extracts from pupil letters, and reports of committees from different towns. In this part of the report are discussed also the results of the science interest tests and the final information test, together with such inferences or conclusions that may be drawn.

Under Summary and Conclusion, the attempt has been made to evaluate the use of the forty science records as an aid to the teaching of science in terms of all the data available. Next are recommendations based upon the judgment of teachers who have used this new aid to the teaching of science.

In the Appendix is given much de-

tailed material on which the summaries are based.

The full report will be printed later, together with the results of additional experiments relating to the use of recorded sound. An extract of this report has been made, copies of which may be obtained by writing to Dr. Irvin Stewart, Director of the Committee on Scientific Aids to Learning, 41 East 42nd Street, New York City.

Space does not permit any detailed report today on the training and experience of the cooperating teachers. It may be pointed out, however, that approximately fifty per cent of the teachers are college graduates, and many have master's degrees. The majority of them have studied one or more of the special sciences. The average teaching experience is 11.4 years, with a minimum of one year and a maximum of thirty-eight years of experience.

Believing that one type of evidence of the teacher's value in the teaching of science is the teacher's hobby or special interest, we endeavored to learn something of the hobbies possessed by the cooperating teachers. It appears that 116 of the teachers have science hobbies, which are organized under some twenty categories. Of these, photography was most frequently mentioned. Nature collecting hobbies of some type or other were next in frequency of mention. Other hobbies have to do with plants, such as the study of wildflowers or the raising of plants. Several teachers reported astronomy as a hobby.

It is of interest to mention the fact that approximately seventy-five per cent of the classrooms in which the science was taught were equipped with running water. Eighty-eight per cent of them had electricity and forty-six per cent had gas. Seventy-eight per cent of the teachers reported that the apparatus available was adequate for the science work required.

With respect to textbooks and reference books, it was found that, in sixty-nine per cent of the classes, one textbook was available for each pupil. Sixteen per cent of the classes had less than one text per pupil. Usually a set was used by different classes. Based on data available, it appears that science references were abundant in twenty-two per cent of the schools, adequate in thirty-four per cent, inadequate in eighteen per cent of the schools, while twenty-seven per cent of the schools did not report on that problem.

With respect to the previous science training of the pupils involved in the experiment, it was found that approximately forty-six per cent of the classes had received little or no previous science training. In twenty-two per cent of the schools reporting the children had had science for the preceding six years.

RESULTS

Among the objectives suggested were the development of principles, certain attitudes, skills and knowledge. Teachers were asked to express their judgment with respect to the extent, if any, to which pupils increased or developed their attitudes of understanding, attitudes of appreciation, and to what extent, if any they were advanced in the use of certain skills. While these results are very subjective, they are of interest. Fifty-nine per cent of the teachers reported that their pupils had gained confidence in the scientific method and its findings. Sixty-six per cent stated that the pupils increased in scientific curiosity. Forty-eight per cent believed their pupils developed a habit of open-mindedness. Seventy-two per cent believed that the pupils advanced in their ability to recognize the law of cause and effect as opposed to superstition and misbelief.

Not only did the great majority of the teachers report that the records were an aid to the teaching of science, but sixty-two per cent declared that the records had much value for teacher training. Twenty-four per cent indicated that they had some value. Less than nine per cent gave as their opinion that the records had no value from

the standpoint of training teachers in service.

As a brief summary to the experiment, it may be stated that approximately eleven thousand children and their teachers completed a successful semester of science aided by recorded sound. A very large proportion of the teachers report that the records promoted interest in the children, as evidenced by the enthusiasm with which they carried on not only classwork but suggested activities outside of school.

The science interest test contained two hundred items, one hundred sixty of which were devised by the Science Evaluation Committee of the Ohio State University. Forty questions related specifically to the topics or content covered by the records. This test provided opportunity for the pupil to indicate his liking for, his indifference to, or dislike for certain items grouped under the following categories:

1. Interest in reading about science.
2. Interest in experimenting in science.
3. Interest in visiting or watching things relating to science.
4. Building or construction projects.

The additional forty questions emphasized these same interests. Time does not permit a detailed report of the result of these tests given before and after the experiment. It may be mentioned, however, that in nine states and in Rochester, the "likes" increased, while the "likes" decreased in four states and were the same in one. "Dislikes" were correspondingly less in eight states and higher in five states and in Rochester, the same in one. These data indicate that on the whole the children liked the items better at the close of the experiment than at the beginning, and that there was less indifference to them.

With respect to "likes" and "dislikes" for experimental work, it appears that pupils' "likes" increased in seven of the fourteen states, decreased in five states, and were the same in two. However, the "dislikes" were lower in seven states, higher in three and in Rochester, and the same in four states. These data indicate increased "likes" for experimental work and less indifference. Approximately the same data are shown for interest in reading and for visiting and construction. Based on these data, it may be inferred that the children as a whole were more interested in various items represented on the test and showed less indifference to various items as the result of their semester's work. It is not to be understood, however, that these changes in interests were due only to the use of the records. Other factors involved in the experiment have been mentioned, and must be considered in summarizing the value of recorded sound.

Certain statistical data were determined for the science interest test and for the final achievement test, results of which are in reasonable agreement with the inferences mentioned above.

In conclusion, it may be stated that, based upon all available evidence, the science records appeared to be a desirable aid to the teaching of science in the following ways:

1. Increased knowledge of facts.
2. Improvement in attitudes of understanding and appreciation.
3. Improvement in scientific skills, including use of the scientific method.
4. Increased interest in scientific things and better discrimination.
5. Improvement in teaching method.

There is also considerable evidence showing that the records were valuable as a means of training teachers in service.

On the basis of the results obtained from this experiment, it appears that recorded sound has a place in the teaching of science. Recorded sound may lack some of the timeliness of the radio program, but its use is much more flexible. The record can be repeated as often as needed for the class or for the individual pupil, whereas the radio program is once and for all. That recorded sound is not a lifeless mechanical thing, but that it brings a personality into the classroom is evident from the comments by both teachers and pupils.

SOME FACTORS IN FREEDOM FOR RESEARCH

OTIS W. CALDWELL
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For a long time Napoleon dominated his people. He subjugated and directed everybody toward accomplishing his own enlarging ambitions. Efforts toward growth of knowledge were stopped, except as they furthered Napoleon's conquests. Hundreds of thousands of individuals, geniuses and leaders, were lost in the battle lines and thus lost to future science, literature, art, and industry; that is, lost to creative thought and to civilization. However, even before Napoleon's military downfall, his intellectual, moral, and physical disintegration were well advanced. Waterloo is recorded as the occasion, but it was neither the time nor the primary cause of the turn of the tide. If not Waterloo, some other crisis would have produced similar results. Increasing defections within the French alliance, resentment at subjugation, as well as the opposition of organized enemies who were willing or who were forced to trade their lives for the hope of their people's freedom, would have found effective expression elsewhere if not at Waterloo.

Historians could cite many cases in which ideals of individual and group freedom appear to have been hopelessly crushed. In spite of the present situation and its discouragements there is reason for thinking that in the long view of history the demand for opportunity and recognition for progressive and creative thought emerges again and again with slow but sure gains in strength and clarity. The kind of individual security that is most needed has developed slowly. Great gains are made, then a catastrophic retrogression occurs, but a view over long periods shows decided advances. If this were not true, the cause of advancing knowledge and human betterment would be hopeless.

The case for freedom is somewhat like that of any other phase of biological evolution. The coherent advances in plant and animal life at times seem to have been unsteady and intermittent. Many of nature's experiments, temporarily successful, have been failures relative to the entire stream of progress. This is made clear by a glance at the termination of some very large side branches in any diagram of long periods of development of either plants or animals. The main growth stem, however, continues upward. I believe that it is so with most of the aspects of growth of human freedom and thinking.

The eminent British clergyman who thought that scientific research should take a ten-year vacation so that people could catch up, misunderstood the fundamental nature both of growing knowledge and of the people. When any part stops developing, it usually dies, and may become one of the lateral and ending branches of the whole series of advancing steps. No pronouncement or dictation can stop the growth of knowledge. Such may for a time put development into temporary abeyance, but, if vital, it emerges again at the return of opportunity.

Research in science teaching is one of the new branches upon the stem of growing knowledge. Being new, it appears to some persons as if it were adventitious and easily pruned away. Some scientific specialists regard research in science teaching as a temporary and terminating evolutionary branch. Whether it proves to be adventitious or a terminating branch depends upon whether the base from which it arises grows firmly into the main stem of scientific development, and whether its main growth continues upward.

Research in science teaching has some features that are characteristic of any scien-

tific research, and some features that are distinctive. The most needful general feature is freedom to investigate, that is, the opportunity, atmosphere, and the expectation that one shall regularly seek new knowledge and improved ways of working. This privilege is commonly asserted, but is too infrequently observed in practice. To say that most people have little vital interest in research, and to say that many if not most do not sense the meaning of search for new knowledge, may be one way of saying that majorities are usually complacent with things as they are. Majorities in world affairs sometimes prefer to accept the authority of the "status quo," of existing knowledge, of precedent, of the dictates of those in charge. In at least many cases, those who have appointed themselves, or whom the majorities have accepted as guides, have been able to succeed partly because so large a percentage of people readily acquiesce and may for a time prefer such leadership. However, when any purposeful minority starts gathering data, deriving and verifying conclusions and giving effective publicity to their proved conclusions, at that time merely authoritative leadership begins its decline in influence.

The privilege of engaging in research in science teaching carries with it the obligation that enduring research shall be done. I am using the word, research, in no superficial sense. I mean that men and women shall discover things with such valid proofs, that other workers using the same data under corresponding circumstances will prove the same things. Such a standard is very difficult to achieve. In many cases, unavoidable variations in situations or methods produce differences in results, but we should make better analyses of these variations so that we may better judge any differences in findings. A piece of research can rarely be completely dissociated from all its variables. Even the best piece of research when reported, is usually but relatively accurate and complete, and almost always undergoes changes when more is later learned about the variable factors.

Because so little is as yet definitely proved about science teaching, the danger is great that there may be excessive confidence in announced results of specific studies. If more were known, possibly those doing single pieces of research might sometimes be less assertive. It is notable that in other scientific fields those who possess most knowledge and who are steadily engaged in research are usually quite humble about their own researches. It is easier to be dogmatic when least is known. There is greatest danger of dogmatism when there is a small amount of proved knowledge for use. In the long view, our freedom for research will continue in terms of the validity and continuity of what we do.

Those who respect the spirit of research always question the "status quo," though they do not wish to discard it until more is known. An illustration may show what I mean. Nearly forty years ago some of us had serious difficulty in effectively introducing young pupils to science by use of full years of highly specialized text and individual laboratory courses in botany, zoology, physiography, physics, and chemistry. When we began experiments, which we now recognize were rather chaotic, I was vigorously accosted by an eminent, able, and authoritative educator who said: "Why not let good enough alone? Why change the subjects and organizations which we have worked so long to get adopted?" But experimentation with the purpose of improvement continued, and finally resulted in a topically organized introductory course which gave improved teaching results. Even without adequate evidences of measured outcomes, which later became possible, interest soon increased and participation from pupils made it evident that we could not accept a policy of letting "good enough alone." The reason is that what was being done was not "good enough." The introductory science courses today are

not "good enough," except that adequate experimental teaching and testing have not yet produced the next steps which are needed.

Research in science teaching needs to take into account the trends of thought and action of our society. The next steps in organization will probably exhibit a better recognition of our whole philosophy of education as the means of developing a better civilization, and not primarily the existing results of our present civilization. That is a large order. Thus far the books and magazine articles looking in that direction have attempted little more than to blaze the trail by philosophic discussions. They have not shown teachers what to do. Research *must* do that, and scientific research is not within the field of the philosopher. Yet sound educational philosophy must help us in all we do.

Most of us now accept the problem philosophy of learning. That has been often stated, the form and illustrations varying. He may paraphrase the philosophy by such statements as the following:

A teacher cannot really teach unless the pupils do their own learning. You teach, I learn.

Pupils do not learn unless they possess questions to be answered, problems to be solved. Unless there is sensitized film, light and experiences will not make a record no matter how good are the light and focusing lens. Questions and problems are sensitizing. No amount of exposure or later methodical development can produce a printing picture within an unsensitized plate.

This gives the philosophy of interest a more fundamental meaning, not the fitful and rapidly shifting thing depicted by some critics, but a glue-like quality which can make its contacts secure. When interest is present, directed effort and measurable achievements become possible.

The effective teacher, therefore, makes sure that his learners possess interest, either of their own initiative or transplanted by him into their full possession.

Now, those are some of the essential qualities of research as well as of learning. They are some of the foundations of experimentation. Each teacher who is advancing therefore, becomes an experimenter, a research student of his own teaching. While his pupils are learning, he is experimenting on how they learn. The philosophy which is pertinent in their progress is also pertinent in his own never-ending study of their progress. If he has interest in his teaching, its many problems are always pressing for his planned and directed effort and for measurement of his own results, as well as measurements of his pupils progress.

Freedom for such experimentation is far from full realization. That comes slowly. Carefully detailed and printed courses of study, supervised by appointed overseers are necessary because most teachers are as yet incompetent to use in their own teaching problems the philosophy and methods which are characteristic of the best classroom practices. Most teachers are not investigators, hence the necessity of obedience to set outlines, printed procedures, and authoritative supervision. Most teachers cannot now be free to investigate because they have not the qualities through which to use such freedom.

This brief outline emphasizes some of the obligations and opportunities before this association. Although the majority of schools are not experimenting, many will welcome trained research men and women who have developed carefully planned experiments which offer possible improvements. The uses of science in education—elementary, secondary, college, graduate, and adult—seem most likely to be improved in much the same way as are other uses of science. Not by mass attack, but by many separate and specific investigations, each of which is as dependable as our insight and techniques now make possible. Any specific study is complete only in a very narrow sense. The cumulative results

of many related studies, each good enough to be quite worthy of science, the whole series producing new trends of thought in science teaching, are what is needed. Toward the development of such well-proved and carefully tested trends of thinking, it seems to me, we now need to guide our efforts.

RESEARCH AND THE SCIENCE TEACHER *

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The value of research has been demonstrated conclusively in professional fields, such as medicine and engineering. Many of the attainments and most of the progress in these fields have been made possible through research carried on by skilled workers. Some of the workers devote all of their time to laboratory experimentation while others who are actively engaged in their profession are applying, testing, and refining the results of research; are defining new relationships; and are isolating new problems.

Educators like doctors and engineers believe that their profession, too, should rest on a substantial scientific basis. To this end, workers in various educational laboratories are making studies concerned with adult learning; the growth of boys and girls; the way learning takes place; interests, capacities, habits, and attitudes; methods of procedure; and teaching techniques. The results of studies along these lines have influenced teaching methods, the preparation of teaching materials, and the development of school programs. Progressive teachers are using the results of such experimental work as well as carrying on investigations in their own classrooms under normal teaching situations.

There is a general tendency today in educational practice to draw more and more upon the resources made available by research. This is a natural outgrowth of thinking of education in terms of active, growing young people. Teachers want to know more about the way present-day training functions in life situations and meets the demands of a rapidly changing society. They want to know how students can be directed in the development of attitudes, habits, and skills that are important in making them happy and worthwhile citizens.

The first studies in which educational research was applied to problems in the teaching of science were made about thirty years ago. Since the publication of these pioneer investigations, a rapidly increasing number has been made. During these years, there have been many advances in psychology and statistics and the development of new and more trustworthy techniques that have made later investigations more reliable and consequently more valuable.

Nearly every phase of science teaching has been given some consideration by investigators. Some of the areas that have been studied extensively relate to vocabularies, demonstration and individual laboratory work, visual aids, directed study, values of extensive reading, methods of teaching, interests of learners, selection and organization of teaching materials, scientific method of work, and measurement of learning products. It is not likely that any of these studies have solved completely any problem but they have been valuable in clarifying them and serve as stepping stones in the solution of vital questions in teaching.

* Presented at the annual meeting of the National Council on Elementary Science, St. Louis, February 24, 1940.

For example, the results of extensive analyses of vocabularies used in science textbooks have had a marked effect on the choice of words used in the newer texts. They have brought about a definite trend in the direction of simplification of vocabularies. Authors of newer texts are eliminating infrequently used and non-essential expressions and are giving more attention to developing understandings of new words through context, demonstration and experimentation, and through repetition and drill. They are making a definite effort to help students master the essential technical vocabulary involved.

Although investigations have been made in many phases of science teaching, certain areas remain almost untouched. Our present-day rapidly changing society has brought forth many new questions directly concerned with aims, methods, and evaluation in the teaching of science. These changes compel us to re-examine what we are doing in terms of the demands of society. By way of illustration, I will mention five areas in which investigations are needed.

1. To meet the demands of the rapidly changing society, it is necessary to know what these demands are in terms of young people in their everyday living. It is necessary to know what their science needs are as well as what their normal science interests and experiences are. In this connection the word "needs" is used in the sense emphasized in *Science in General Education.*
2. With the changes in society has come a greater amount of leisure time for young and old alike. There is need to know how science can contribute profitably to the use of this leisure time. Gardening is an example of leisure time activity for many people both young and old. Many of the successes and satisfactions resulting from gardening are made possible through contributions of science. We, as teachers, need to know what these science implications are so that teaching may be directed toward a greater understanding of them.
3. With the greater and more widespread use of science and its application there has developed the necessity for increased emphasis on safety measures in the care of modern appliances that form an important part in everyday living. For example, we have a responsibility to emphasize safety in connection with electric wiring in the home, safety in connection with the gas stove and automobile, and in the use and care of acids, poisons, and the like.
4. With increased information and emphasis on natural resources there is need for investigations to help clarify and meet situations relating to conservation that involve science. We need to know and emphasize the science involved in the wise conservation of forests, soils, and wild life.
5. In evaluating our work, we, as teachers, want to know what modifications in the learner, if any, result from science teaching. We believe that a boy or girl who has studied science is different from one who has not studied it. But we need information that can be relied upon and that will help direct teaching procedures in such a way that young people will be able to meet those situations to which even a limited understanding of science and its methods may give an intelligent basis for action.

Although there are many areas needing study, the average classroom teacher may not have an opportunity to make investigations because of lack of time, lack of facilities, or inadequate training. In such cases, she must depend on the work that is done by more or less trained workers. This leads one to ask—What have classroom teachers a right to expect research to do for them? In answer to this question, it seems clear that research can do the following things:

1. Help teachers become cognizant of teaching problems that have been overlooked; recognize the importance of others that they may have been aware of daily; or stimulate them to raise new problems or isolate old ones.
2. Suggest questions to think about, results to test and evaluate, and techniques and procedures to try out.
3. Develop a questioning attitude relating to the validity of instructional methods and objectives of science teaching.
4. Help teachers keep up to date in educational practices and theories; acquaint them with new materials and techniques; and point out trends in educational practice.
5. Orient teachers in evaluating research and in knowing how to attack their own problems.
6. Stimulate teachers to make some original investigation for themselves. Even though the studies may not be extensive or of great importance, they will serve to give a worthwhile educational outlook.

In addition, classroom teachers have a right to expect research to help in clarifying and solving practical questions encountered in everyday work. For example, many investigations have been made that contribute definite help in understanding interests of children as an important factor in teaching. Craig [1] in his study reports that "children's questions cover a wide range of science. They involve the phenomena of astronomy, biology, geology, and physics." Questions collected as in the Craig study are, in the opinion of the author, "not the sole criterion of children's interest. It is possible that children will be interested in materials that are completely foreign to them, if such matter is properly introduced."

Young children's interests consist of activity rather than intellectual interests according to Mau's [2] study. She says that "the kindergarten child's early motor interests are on the things that he himself can do; things for which he furnishes the motor power; it is the engine that he can push or pull, that he can take to pieces and put together again; the bird that he can feed and care for; the flower he can pick; the plant he can water and 'make grow' that are of primary interest. We must keep alive the eagerness to find out how things work and are made in order to establish the scientific habit of mind."

"This motor interest extends far beyond the kindergarten age" is the conclusion reached by Slavson and Speer [3] as a result of observations of children's behavior and learning and "true learning, the acquisition of insight, can best be achieved through activistic and first-hand contact with the materials and facts involved in the learning complex."

Teachers frequently ask, "Are there evidences that children generalize?" Haupt's study [4] shows that children on each grade level generalize in terms of their own experiences—the generalizations on lower levels differing from those on higher levels by being less complex.

Teachers who have little background for making investigations, or who have limited opportunity to do so but have a sincere interest in research, may contribute in a very definite way to increasing knowledge about science teaching.

They may test results of published studies in normal teaching situations. This is an important feature since the results of many investigations are based on limited samplings. The results of such testing should be published for they are often as important as the original study.

They may cooperate willingly with research workers by gathering data from classrooms, submitting new problems and questions, and by carrying out instructions that are part of an extensive study.

They may support organizations that carry on research.

They may use and adapt results of research in normal teaching situations and in this way, study suggested procedures or practices in the light of demands of society as indicated in their particular center.

In essence, then, every science teacher may be a research worker trying out new methods, new techniques, and new teaching materials.

To function extensively, the results of experimental work in special fields as well as in general education must be in the hands of classroom teachers or classroom teachers must at least know where to find them. It is possible for teachers to keep informed about the experimental work in their field of interest in the following ways: (1) By

[1] Craig, G. S. *Certain Techniques Used in Developing a Course of Study for the Horace Mann Elementary School.* Contributions to Education, No. 276. New York: Bureau of Publications, Teachers College, Columbia University, 1927.

[2] Mau, Laura E. *Some Experiments with Regard to the Relative Interests of Children in Physical and Biological Nature Materials in Kindergarten Grades.* The Nature Study Review 8: 285–291; November, 1912.

[3] Slavson, S. R. and Speer, R. K. *Science in the New Education.* New York: Prentice-Hall, 1934.

[4] Haupt, G. W. *An Experimental Application of a Philosophy of Science Teaching in an Elementary School.* Contributions to Education, No. 633. New York: Bureau of Publications, Teachers College, Columbia University, 1935.

reading the most important research studies published in book form, in the leading magazines relating to the teaching of science, in magazines devoted to research, and in society yearbooks; (2) By attending and taking membership in local, state, and national organizations which provide opportunities to hear men and women tell about their work; and (3) By enrolling in courses offered by colleges and universities.

In large centers, the problem of making research available may be in the hands of the supervisory staff which can select, organize, and digest the most valuable investigations and present to teachers the entire studies, digests of them or interpretations of results of data. Keeping teachers informed of work that is being done in their fields of interest is a definite step toward improving instruction. It is likely that progress in science teaching is, in large measure, dependent upon it. The implications involved in keeping teachers informed will tend to make them sensitive to methods and procedures in their own classrooms and will differentiate between the teacher who is creative and a leader and the one who is a routine worker or follower.

This brief discussion indicates, that research studies relating to science teaching, both academically and professionally, have advanced rapidly and have done much to clarify teaching problems. It indicates further that there are large areas in need of study and that every teacher may have an important part in improving the teaching of science through research. Teachers should not expect research in science, especially in its present limited stage, to answer all of their questions. Rather, they should expect research to indicate a desirable approach, a sign along the highway of educational progress. In closing, permit me to quote from *Science in General Education*,[5] "Science has provided a great many tested methods and techniques which man can use with confidence in attacking his problems. Yet the use of these tools in solving the crucial problems of social living is, in large measure, one of a promise in the future and points to a new and increasing responsibility for the science program in the public school."

[5] The Commission on Secondary School Curriculum. Progressive Education Association. *Science in General Education*. New York: D. Appleton-Century Co., 1938.

THE SCIENCE INTERESTS OF SUCCESSFUL ELEMENTARY TEACHERS *

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The science interests of elementary teachers has received little attention from those who are interested in science education. Although there are several investigations of the science interests of pupils and a good start has been made in determining the science interests of laymen, the writer has been unable to find in the literature a single report of the science interests which characterize the successful elementary teacher. It is the purpose of this paper to indicate partially the significance of this area of investigation and to present some results of an attempt to determine the extent to which successful elementary teachers exhibit certain limited patterns of science interests.

This area of investigation would seem to be significant because of three well established principles and facts:

* Address before the National Association for Research in Science Teaching at St. Louis, Missouri, Feb. 26, 1940.

1. That a twelve-year science sequence is desirable in the elementary and high schools.
2. Many elementary teachers lack sufficient science training to guide adequately the science learnings of active inquisitive children.
3. Teachers tend to teach those things that are attractive to them regardless of the insistence of supervisors and curriculum makers to the contrary.

Although elementary teachers are receiving increasingly adequate training in science, it is still true that most of them have quite limited formal science training at the college level. The National Survey of the Education of Teachers conducted by the U. S. Office of Education showed that, in 1930–31, approximately three-fourths of the elementary teachers had received a total of two years or less of college training. The National Education Association Research Bulletin for January, 1940, indicates that the median elementary teacher in cities of 2,500 and above has received 3.4 years of college training. The college training of elementary teachers in smaller cities, towns, and rural areas is certainly less than that for larger cities. Obviously, teachers with less than two to four years of college training to cover the wide area of knowledges and skills necessary for elementary teaching will have little time devoted to science training, perhaps none devoted to practice in science teaching.

It thus becomes apparent that elementary teachers who adequately teach their portion of the twelve year science sequence must obtain much of their science training either while in service or in other than formal teacher training activities. A significant group of such extra formal trainings will accrue from those things which a teacher does simply because she likes to do them. Conversely, such extra formal trainings will not be received from those activities which the teacher avoids because she does not like to do them. From this standpoint those things which a teacher does as a matter of personal interest over and above regular class room and formal training activities may be quite influential in determining her science skills and knowledges. If teachers have interests which lead to a science background considered desirable for the elementary school, then supervisors and principals should provide opportunities and encouragement for the exercise of these interests. It would seem also that supervisors could make a more psychological approach to in-service training if the teacher were started on some kind of activity which she normally enjoys. Superintendents could improve the quality of science teaching in the elementary schools if they would select teachers whose interests are in specific activities which involve science understandings and skills appropriate for the elementary school. In short, here is an area of teacher likes and dislikes in occupations, group amusements, personal recreations, readings, school subjects, characteristics of people, and the like which could be capitalized as a potent force in the improvement of science instruction.

The first step in the investigation of this area of teacher likes and dislikes would appear to be the determination of the science interests of elementary teachers who are considered to be successful by competent principals and supervisors. Science educators would then be in a position to pass judgment on the interests revealed and to make suggestions for such changes as would be desirable. In connection with a three year study of the total interest patterns which characterize successful elementary teachers, the writer has found it possible to identify interests which seem to be related to certain aspects of the various fields of science. The remainder of this paper will be devoted to a summary of the findings from this study.

Any attempt to determine the interests of successful teachers makes it necessary to establish a criterion group of teachers which for purposes of the investigation will be classified as successful. For this investigation it was considered desirable to include in this group only teachers who

were considered successful by supervisors or principals who had sufficient experience in judging teachers to make them competent judges. This group of judges was established through the professors in Elementary Education and School Administration in the State Universities of the geographical areas used, namely, Nebraska, Missouri, Kansas and Iowa. Professors in each of these universities were asked to furnish a confidential list of superintendents, principals, and supervisors who in their opinion ranked among the very best they had ever known in the ability to identify genuinely outstanding elementary teachers. No trait other than this ability to identify successful teachers was to be considered in the selection. Each professor was informed of the nature of the investigation and was assured that he would not be quoted in any manner regarding his selections.

Each person on the master list of superintendents, principals, and supervisors thus obtained was asked to give the names and addresses of the best elementary teachers they knew. Each was requested to follow the following criteria in his selection:

1. The teacher must have taught for a minimum of three years under the direct supervision of the judge, but it was not necessary that the teacher be under the supervision of the judge at the time the selection was being made.
2. Each teacher must be a regularly employed teacher at the time of selection.
3. Each teacher must plan, as far as the judge could determine, to teach for at least five more years.
4. All factors of formal training were to be disregarded, the selection to be made entirely on the teacher's expertness in performing her job.
5. Each teacher selected must be one which the judge would consider to be an outstanding successful elementary teacher in every way with no reservations or qualifications.

The selections were limited to women. The sixty-seven judges listed 273 such elementary teachers. Every judge replied to the request by naming one or more teachers.

These 273 teachers were requested to mark the *Vocational Interest Blank for Women* by E. K. Strong, Jr.[1] In addition to the questions asked on the blank, each teacher was asked to indicate the grades taught, special supervisory work, if any, the number of years experience, and the number of years each planned to continue to teach. Replies to these questions made it possible to eliminate from the criterion group any teacher who did not plan to continue to teach or whose work was limited to a special field such as kindergarten, physical education, music, or critic teaching. Checks also were made to determine if the judges had included any one without at least three years experience. No such cases were found. From the original 273 teachers requested to mark the blank, 238 replies which met the criteria were received. These 238 teachers constitute the criterion group of successful teachers from which the data of this study are derived.

The *Vocational Interest Blank for Women* consists of 410 items to each of which the person indicates her interest or preference on a three point scale. For most of the items the response is L if the person thinks she would like to do what is involved in the item, I if she would be indifferent, and D if she would dislike to do the things involved. For some items it is necessary to make a three point choice between two activities; that is, whether there is equal interest in the two or which of the two is preferred. A few items are arranged in groups of ten, and the person is asked to mark the three items liked best, the three liked least, and the remaining four are marked at the middle point on the scale. The blank includes items on occupations, amusements, activities, peculiarities of people, order of preference of activities, comparison of interests between two activities, self estimates of abilities and characteristics, and interest in a variety of school

[1] Stanford University Press.

subjects. Such of the above items as pertain to science are considered in this study. No attempt is made to cover all kinds of science interests; the material being restricted to that obtainable from the Strong blank.

TABLE I

INTERESTS OF SUCCESSFUL ELEMENTARY TEACHERS COMPARED WITH INTERESTS OF WOMEN IN GENERAL

Item	Percentage El. Tch.			Percentage Women General			Strong-Kelley Weights		
BIOLOGY AND PSYCHOLOGY									
	L	I	D	L	I	D	L	I	D
377. Botany	60	30	10	60	29	11	0	0	0
401. Physiology	51	36	13	59	28	13	–1	1	0
410. Zoology	37	41	22	47	35	18	–1	1	0
16. Biologist	29	32	39	36	33	31	–1	0	1
13. Bacteriologist	20	35	45	30	33	37	–1	0	1
403. Psychology	76	19	5	79	15	6	0	0	0
88. Psychologist	54	31	15	55	27	18	0	0	0
87. Psychiatrist	51	26	23	48	27	25	0	0	0
ENGINEERING, ARCHITECTURE AND RELATED OCCUPATIONS AND ACTIVITIES									
	L	I	D	L	I	D	L	I	D
5. Architect	29	48	23	42	41	17	–1	1	1
12. Aviatrix	11	26	63	25	33	42	–1	–1	2
64. Mechanical Engineer	3	37	60	10	34	56	–1	0	0
394. Mechanical Drawing	11	50	39	22	40	38	–1	1	0
32. Draftsman	9	46	45	15	41	44	–1	0	0
142. Solving Mechanical Puzzles	24	37	39	28	34	38	0	0	0
178. Operating Machinery	14	42	44	24	34	42	–1	1	0
179. Repairing Electrical Wiring	10	36	54	19	31	50	–1	0	0
Comparison Between Two Items									
306. Aviatrix—Stenographer	18	23	59	38	27	35	–2	0	2
GEOGRAPHY AND GEOLOGY									
	L	I	D	L	I	D	L	I	D
386. Geography	76	16	8	74	19	7	0	0	0
387. Geology	34	51	15	47	41	12	–1	1	0
168. "National Geographic" Magazine	90	10	0	85	14	1	0	0	0
HEALTH AND RELATED OCCUPATIONS									
	L	I	D	L	I	D	L	I	D
30. Dentist	2	22	76	10	22	68	–1	0	1
54. Laboratory Technician	17	35	48	20	35	45	0	0	0
72. Nurse, graduate	31	25	44	26	25	49	0	0	0
73. Nurse, public health	26	29	45	25	28	47	0	0	0
77. Pharmacist	14	45	41	15	40	45	0	0	0
78. Physician	30	29	41	47	23	30	–1	1	1
111. Surgeon	20	29	51	37	22	41	–2	1	1
HOME ECONOMICS									
	L	I	D	L	I	D	L	I	D
381. Domestic Science	60	32	8	54	31	15	0	0	–1
21. Caterer	17	35	48	19	29	52	0	1	0
26. Confectioner	15	49	36	11	37	52	0	1	–1
27. Cook	37	29	34	32	25	43	0	0	–1
115. Teacher Domestic Science	35	37	28	21	33	46	1	0	–2
187. Cooking	65	23	12	60	23	17	0	0	0
188. Sewing	47	26	27	40	28	32	1	0	0
207. Trying New Cooking Recipes	64	25	11	54	28	18	1	0	–1
31. Dietitian	31	41	28	30	34	36	0	1	–1
28. Costume Designer	58	27	15	46	31	23	1	0	–1
Comparison Between Two Items									
317. Preparing a meal—Making a dress	56	29	15	55	31	14	0	0	0

TABLE I—*Continued*

Item	Percentage El. Tch.			Percentage Women General			Strong-Kelley Weights		
MATHEMATICAL BACKGROUND AND RELATED ACTIVITIES									
	L	I	D	L	I	D	L	I	D
372. Algebra	62	14	24	60	13	27	0	0	0
373. Arithmetic	61	21	18	57	14	29	0	1	−1
378. Calculus	8	45	47	19	38	43	−1	1	0
388. Geometry	43	21	36	48	20	32	0	0	0
408. Statistics	15	44	41	25	33	42	−1	1	0
108. Statistician	18	33	49	18	29	53	0	0	0
Comparison Between Two Items									
305. Statistician—Social Worker	16	20	64	16	21	63	0	0	0
NATURE STUDY AND RELATED ACTIVITIES									
	L	I	D	L	I	D	L	I	D
396. Nature Study	74	21	5	68	27	5	0	−1	0
71. Naturalist	49	38	13	47	38	15	0	0	0
140. Observing Birds	73	18	9	58	33	9	1	−1	0
149. Animal Zoos	70	25	5	58	29	13	1	0	−1
151. Museums	81	17	2	77	20	3	0	0	0
68. Museum Director	23	43	34	25	36	39	0	1	0
177. Raising Flowers and Vegetables	67	25	8	66	27	7	0	0	0
41. Florist	64	26	10	52	37	11	1	−1	0
55. Landscape Gardener	58	28	14	57	29	14	0	0	0
40. Farmer	22	31	47	28	27	45	−1	0	0
166. "Home and Garden" Magazine	83	17	0	74	23	3	1	−1	−4
PHYSICS AND CHEMISTRY									
	L	I	D	L	I	D	L	I	D
379. Chemistry	25	37	38	44	28	28	−2	1	1
400. Physics	19	37	44	39	33	28	−2	0	1
22. Chemist	16	33	51	27	34	39	−1	0	1
SCIENTIFIC RESEARCH									
	L	I	D	L	I	D	L	I	D
102. Scientific Research Worker	24	40	36	38	34	28	−1	1	1
52. Inventor	23	51	26	31	46	23	−1	0	0
201. Doing Research Work	48	36	16	55	29	16	−1	1	0
SCIENTIFIC WRITING AND ILLUSTRATING									
	L	I	D	L	I	D	L	I	D
11. Author of Technical Book	11	40	49	24	41	35	−1	0	1
101. Scientific Illustrator	11	50	39	17	48	35	−1	0	0

Table I presents the items in an arbitrary classification. Whether or not all agree on the classification of any given item is of little importance as the arrangement is presented merely to facilitate discussion. In the first column is the number and the item from the Strong blank. In the next three columns headed L, I, and D are the percentages of successful elementary teachers who responded to each item in each of the three categories. The second three columns headed L, I, and D show the percentages of women in general who respond each way to each item. These data for women in general were obtained from Professor Strong and are used by him as basic points of reference in constructing scoring keys for measuring interests in various occupations by use of the blank. The last three columns headed L, I, and D represent weights derived by the Kelley-Strong formula [2] for the comparison between the percentages for elementary teachers and women in general. These weights represent those which would be used if these items were included in a key to measure the extent to which a testee has interests similar to those of the criterion group of elementary teachers.

[2] Kelley, T. L. "The Scoring of Alternative Responses with Reference to Some Criterion," *Journal of Educational Psychology* 23: 504–510; 1934.

If in examining the percentages for the group of successful elementary teachers 50 per cent is considered as the critical point, it is possible to indicate the likes and dislikes held by a majority of the group. All of the L, or like, responses equal to or greater than 50 per cent are found in the following classifications: biology and psychology, geography, home economics, mathematical background, and nature study. All of the D, or dislike, responses equal to or greater than 50 per cent are found in the four classifications of engineering and related occupations, health, mathematical background, and physics and chemistry.

Continuing this same 50 per cent critical point, the specific areas of "like" in biology and psychology are the school subjects of botany, physiology and psychology. More than half of the group think they would like to be a psychologist or psychiatrist. In no instance do half of the group dislike the activities in this classification. They would appear to be indifferent to zoology and the occupations of biologist and bacteriologist. Engineering, architecture, and related occupations and activities represent a small percentage of the like responses in every item. The typical pattern according to the 50 per cent criterion is either indifference or dislike. The study of geography and reading the "National Geographic" magazine are liked by more than three fourths of the group, while half of them are indifferent to geology. In general, very few of the elementary teachers think they would like occupations related to health. The pattern seems to turn in the direction of dislike. Although only dentist and surgeon are disliked by half or more of the group, every item receives a dislike percentage of more than forty. The home economics classification presents a mixture. In general the study of domestic science and applications in the home such as sewing, cooking, and costume designing have strong appeal. The out of home applications such as dietitian, caterer, and confectioner are not liked.

Those aspects of mathematical background found at the less advanced levels of training are liked. Advanced courses such as calculus and statistics are not liked. Nature study and related activities are liked by more than 50 per cent in nearly all of the phases listed. Museum director and farmer are the outstanding exceptions. Physics, chemistry, research work, and scientific writing in general are not liked. Let us keep in mind that the above summaries are based on a purely arbitrary critical point of 50 per cent. Actually, any other critical point could have been chosen for there is no assurance but that 40 per cent, 60 per cent or some other percentage would be equally valid.

It does seem that a better interpretation would be obtained from a comparison between these elementary teachers and women in general. If the twelve-year science sequence is to function, then it would seem a reasonable minimum to expect elementary teachers to possess greater interests in scientific things than a representative sample of the female population. A comparison between the first group of L-I-D columns and the second group in Table I shows the differences between elementary teachers and women in general.

Probably one of the easiest and most nearly valid methods of comparing these two groups is to use the Kelley-Strong formula for determining weights appropriate for each response. The formula is quite involved and it is not necessary for us to go into it here as its presentation is made adequately in the published literature. These weights with a possible range of −4 through +4 are given in the last three columns. Plus weights indicate that the elementary teachers' percentage is more than that for women in general, and minus weights indicate the opposite. Plus weights in the L column and minus weights in the D column would represent desirable weight-

ings from the standpoint of the science educator.

An examination of these weights reveals that the science interests of elementary teachers are certainly no more pronounced than those interests for women in general. There are only eight plus weights in the L column. All of these have a value of 1 and fall in the two classifications of home economics and nature study. The sum of all the weights for the L column is –23; for the I column it is 12; and for the D column it is 1. This means that a person who likes all of the items listed here would have less resemblance to the science interests of the typical successful elementary teacher than the person who is indifferent or dislikes all of the items. Or putting it another way, women in general exhibit a stronger like for the activities indicated by these science items than do successful elementary teachers.

What are the implications of these findings for science educators? The answer is not so easy because it must be remembered that the above data represent only a small portion of possible science interests, and sweeping conclusions are not justified. Pending further and more complete investigations of this problem, it would seem that the following trends are indicated in the science interests of successful elementary teachers.

1. Successful elementary teachers have certain science likes which are largely in the areas of nature study, geography, biology, the home making aspects of home economics, and the oeginning levels of mathematics background.
2. These teachers have certain science dislikes which are largely in occupations related to engineering and health; the fields of physics, chemistry, geology and advanced mathematics; and activities involving primarily scientific research, writing, and illustrating.
3. The science interests of successful elementary teachers show fewer likes for science than do the interests of women in general.

If the science educators desire in the elementary schools teachers with strong science interests, then they must see that employment officers exercise greater care in selecting appointees in this respect; or they must devise an in-service training program which will change the interests of relatively mature people. It has never been demonstrated that the latter can be done.

THE PLACE OF TECHNOLOGY IN GENERAL EDUCATION

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Much has been said and more has been written during the last few years regarding the place of the so-called "cultural" subjects in the engineering curriculum. The value to the engineer of a knowledge of the humanities has been widely and sometimes hotly debated. This has resulted in the growth of two distinct schools of thought among engineering educators: one which regards engineering as a trade or vocation in which the main objective is to develop certain technological skills; and another which takes a broader and more professional view, and which holds that the engineer is, after all, a human organism and, as such, has a moral responsibility for the impact of his technology on the whole social situation. To better understand and evaluate these social effects, the latter group advocates a groundwork of the humanities in engineering education.

Both groups, however, overlook one important corollary which grows out of their controversy, namely, whether or not a knowledge of the techniques of applied science has a place in a scheme of general education. Should the "cultural" or "educated" person have any knowledge or appreciation of the methods of the technologists?

The curriculum of every liberal arts college offers many courses designed to develop the appreciation of art, music and literature, but no course can be found which has as its objective the appreciation of the place of science and technology in modern civilization. True, most college curricula include one or more science survey courses but these are designed more to enable a student to meet the science requirements of the baccalaureate degree than to develop an appreciation of the part applied science plays in the daily life of the common man. And these survey courses are usually taught by physicists, biologists, and chemists, not by applied scientists who are otherwise known as engineers.

Engineers are fond of saying that an engineering education makes the best foundation for life in an industrial civilization, and that the man or woman who has had the benefit of such an education is better equipped to do a variety of jobs, outside the field of engineering, than he otherwise would be. This is undoubtedly true in general, but the fact remains that a large majority of the college population is not equipped to withstand the rigors of a complete engineering curriculum, the main objective of which is the mastery of professional techniques. However, if the limitations of complete mastery were removed, these same students might derive great benefit from some slight contact with the methods and ideals, call it the philosophy, if you will, of technology. Courses in music appreciation are not failures because they produce no Wagners or Beethovens and by the same token, a course in the appreciation of engineering should not be expected to produce a Goethals or a Holland.

Nothing has so profoundly changed the trend of human thought in the last hundred years as have the results of scientific inquiry as applied by the technologists to human living. Philosophy, religion, economics, politics, in fact every field that can be mentioned, have all been shaken to their depths by the impact of science, either pure or applied.

As one example, consider the tremendous change in the attitude of the Catholic church toward science between the times of Galileo and Newton. When Galileo dared to publish his theories of the formation of the universe, he was forced by the church to recant, yet when Newton published his laws of gravitation and applied them to the Solar system, the church commissioned one of its leading scholars to investigate Newton's theories and Newton was never even suspected of heresy.

Even in the field of philosophy, where it might least be expected, science has had a profound effect. The method of scientific inquiry, of testing hypotheses for truthfulness, everything which is included in the term "scientific method," has changed Scholasticism to Pragmatism and Experimentalism. The fields of economics and sociology offer so many examples of the effects of applied science on the lives of the people that specific instances would only become wearisome.

There exist in America today two types of minds and all too frequently these two types inhabit the same body. One is the mind which is reflected in our technological civilization. Within its limits it is the scientific mind. The American who uses machinery to plow his fields, to harvest his crops; who travels in automobiles, railroad trains, and airplanes; who builds steel bridges and erects skyscrapers; who utilizes electricity to light his house, to iron his clothes, and to toast his bread—this American has habits of thought and action which possess something of the qualities of science.

The second mentality also has its characteristic type of expression. It is exhibited in skyscrapers that omit the thirteenth floor, in the thousands who rush to a shrine to find in its magic a cure for disease, in fundamentalists whose belief in an infallible book prompts them to pass laws prohibiting the teaching of scientific theories about the origin of man.

The existence of these two types of minds side by side constitute something of an indictment of our scheme of education. Science and technology together constitute the most powerful force at work in the world today, molding the social order of the future, and yet in the present scheme of general education, this mighty influence is almost completely ignored. The secondary schools have made a beginning, it is true, but general education at the college level is very far behind.

Has not an appreciation of science and technology just as appropriate a place in a liberal arts curriculum as have art and music? We study the lives of musicians, politicians, and soldiers, and yet there is as much inspiration in the lives of Pupin, Gorgas, Pasteur, and Newton as there is in the lives of Wagner, Bach, Titian, and Michelangelo, to say nothing of their relative contributions to human welfare. Leonardo da Vinci is remembered for the Mona Lisa—but who realizes that his contributions to engineering far outweigh even that masterpiece?

So the thesis is presented here that in a scheme of general education which is designed to "improve life," to quote Kilpatrick, an appreciation of science and technology should be given a proper place.

Appreciation does not imply mastery. It is not necessary to be able to derive the equation of three moments to get a thrill out of knowing something of the labor involved in designing and erecting an Empire State Building or a George Washington Bridge. Nor is it necessary to be able to perform an appendectomy to appreciate the efforts that a city expends to guard the purity of its milk and water supply.

Such an appreciation of the place of technology in modern civilization is one of the necessary parts of a well-rounded education today, and it can be taught with surprising results. Some five years or more ago, such a course was offered in the summer session of a large Eastern university. Nothing startling was expected in the way of registration, yet the first class numbered close to one hundred students, at least three-quarters of whom were women. Since then the popularity of the course has jumped by leaps and bounds.

The method used in teaching this course was to select those scientific principles which are used in solving the problems that are a natural consequent of life in a large city. The development of these principles by the pure scientist and their application by the technologist were followed from the research laboratory to the finished bridge, sewage disposal plant or water supply system by means of lectures, illustrated where possible, discussion groups and inspection trips. The objective was not to train technologists, but to give the average student some understanding of the place of applied science and the scientific method in his daily life.

This beginning has been made in only one institution. If such a course could become the recognized part of every liberal arts curriculum, the ideal of a population sensitive to the scientific solution of its problems might be arrived at and the reign of the political demagogue with his long line of bunk might be ended. It would not come about in this generation nor in the next, but the idea is worth thinking about.

MATERIALS AND METHODS AS FOUND IN GENERAL SCIENCE TEXTBOOKS PUBLISHED SINCE 1910 *

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In making a study of the above subject, some eighty-four textbooks, dating from 1910 to 1936, were examined, page by page, and from that number twenty books were chosen as being representative of the years in which they were published. Since these years of publication were rather evenly distributed over the period of the study, it was assumed that the study would show the development of the general science textbook during the first third of the twentieth century.

The study was divided into three periods: (1) 1910 to 1919, (2) 1920 to 1929, and (3) 1930 to 1938. These divisions were made on the basis of apparent changes in method of presenting materials.

Two comparisons were made: (1) A comparison of the amount of space devoted to the biological sciences and to the physical sciences, and (2) the trends revealed in the distribution of subject matter.

An analysis of the space in the twenty general science textbooks for the period from 1910 to 1936 revealed the following points:

1. The greatest amount of space was devoted to physics during each period, and by all the authors except one.

2. Physics is the only one of the six phases of science which received as much as half of the entire space in any of the books. The trend is toward uniformity among the different authors, and there has been a steady increase in the amount of space devoted to physics since 1910.

3. It is significant that while the amount of space devoted to physics increased about 13 percentage points during the period of this study, the space devoted to physical geography decreased about the same amount. But the decrease in physical geography was not gradual. A decrease of about one-half occurred at the beginning of the second period, about 1922, and since that time physical geography has received approximately the same average space.

4. The decline in the importance placed upon physical geography was accompanied by an increase upon the emphasis placed upon chemistry. The authors are now devoting 14 per cent of the space to physical geography as compared to 27 per cent during the first period of the study.

5. While chemistry ranks third in importance with an average of 16.3 per cent for the three periods as a whole, the present-day authors give it fourth place. In fact, the average space devoted to chemistry since 1930 is less than during either of the two earlier periods. In the last period, a large portion of the space was taken from chemistry and given to physiology.

6. Physiology received about 13 per cent of the space during each of the first two periods, but the tendency was toward increase during the last period. While the average space devoted to physiology placed it in fourth rank for the study as a whole, the authors of the last period gave it second place.

7. The amount of space devoted to botany has remained approximately the same since 1910. There were variations among the different authors in all the periods, but this phase of science was more consistent than any other phase in receiving the same average amount for each of the three periods. The average for study as a whole was 9.2 per cent.

8. Zoology received the least average

* Adapted from a Master's Thesis, University of Texas, 1938.

amount of space of the six phases of science during each of the three periods. In the second period, there was an indication that the textbook writers had begun to feel that Zoology had no place in the general science course, for two of the books analyzed contained no subject matter pertaining to Zoology. In the third period, the trend was decidedly toward less space, the average for that period being only half of the average for the second period.

9. While there was considerable shifting of emphasis among the six phases of science during the different periods, the average amount of space devoted to each of the two fields of biological science and physical science remained approximately the same; 27.5 per cent of the space was devoted to biological science, and 72.5 per cent to physical science.

A study of the methods used in twenty general science textbooks published from 1910 to 1936 warrant the following conclusions:

1. There was a steady increase in the number of visual aids, throughout the three periods into which the study was divided; the ratio of distribution among the different visual aids remained approximately the same.

2. Only three books of this first period had maps, whereas, during the last period, the same number of maps was distributed among all six of the books studied.

3. Graphs received very little emphasis in any of the periods, but in the last period, there was a tendency for more to be included.

4. Beginning in 1916 and 1917, the authors emphasized the importance of the student's doing things for himself. Projects were introduced and more problems were included than formerly. Efforts were made to provide for individuals. During the second period, most of the authors adopted the project method, or a combination of problem-project method, and began to arrange their material by units. During the third period the problem-project method was continued, but with not so much enthusiasm on the part of the authors.

5. During the second period, reports were introduced and continued with little emphasis in the third period; during the third period debates as an aid were introduced; during the second period, field trips were introduced and continued during the third period, but they received little emphasis.

6. Throughout the study, the authors used questions as the principal testing aid. Just after the introduction of the problem-project method, there was an increase of about 400 per cent in the number of questions used. The last period shows a reduction of approximately 25 per cent in number. The questions in the newer books, however, seem to be better suited to the problems and projects.

7. In 1928, one author used key words and key sentences as testing aids in addition to questions. In 1930, another author used a similar device which called for definitions.

8. There was a continuous increase in the number of references given during the whole study, but only half of the authors studied for the last period gave references in their books. The tendency at the close of the study seemed to be toward annotated bibliographics.

9. The development of the summary as an established aid was a slow and gradual process, but approval was given the summary by all the authors studied for the last period.

10. Previews were introduced during the last period by five of the authors.

In conclusion, the methods in the first period were in some measure deductive; the problem and project methods were given much emphasis after 1919, and the most evident characteristic of general science textbooks since 1930 is the added number of supplementary aids.

READING GUIDANCE IN HIGH-SCHOOL SCIENCE CLASSES

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Are science teachers in the secondary schools of the United States reorganizing their methods of instruction to vitalize the work for the majority of the pupils enrolled? If efforts are being made to break away from the "textbook-quiz" and lecture methods, what are the new methods meeting with approval?

It was with the purpose of seeking the answers to these questions that the author, in 1937–8 made an extensive study of published statements of leading educators and of methods being employed by science teachers. This study was conducted with a twofold purpose: (1) to summarize the published opinions of leading educators concerning the desirability of guiding pupils into broader reading for science concepts; and (2) to investigate the activities of science teachers in making use of suggestions to extend assignments beyond a single text.

The most vital problem confronting school directors in the United States today is the adjustment made necessary by increased enrollments. School populations are no longer composed largely of those planning specialized careers, as was the case in the early history of our schools. Various proposals have been made and discarded as undemocratic and false, but now there seems to be a settled feeling that the adjustment to individual capacities can best be taken care of by employing new methods of instruction which guide the pupils into ways and means of seeking and finding information necessary to the solving of problems in which they are vitally interested. Methods of instruction designed to broaden the readings of pupils beyond a single text have found favor in many classrooms, but *science* teachers have been skeptical. They have hesitated to break away from traditional routine teaching of facts. Many still feel that the science class work in the secondary schools must be concerned primarily, with the preparation of future specialists. Although much has been written to urge science teachers to include a reading guidance program in all science courses of the secondary schools, there is a widespread tendency to leave the entire burden of reading guidance to the English Department.

As an outgrowth of the demand for methods of teaching which will better fit the child of today for the needs of today, interest has been growing in guided reading plans. Systematic investigations which bear upon reading guidance in science classes for secondary-school pupils have been reported. They are of four types—those concerned with (1) values to be derived from extensive reading; (2) adult reading activities and available materials; (3) procedures; and, (4) current practices. In these reports of investigations and experiments, relating to reading guidance in secondary-school science classes, certain outstanding findings should be of general interest. There is an agreement among those who have carried on experiments with extensive reading plans that there are values to be derived from teaching methods which guide pupils in their search for information beyond a single text. Specifically, these values emphasized are:

1. Well guided, broad reading is an effective means of providing for individual and sex differences.

2. Extensive reading of scientific literature serves to increase individual achievement and stimulates the desire of some pupils to proceed further with the study of science in the school.

3. Retention of ideas after a lapse of time is improved by broad reading.

4. Acquisition of scientific information is augmented by extensive reading.

5. Social benefits are to be derived from enriched experience gained from guided reading to vitalize scientific concepts.

6. Pupils' interests can be broadened by suggested readings.

In order that reading activities may be guided in such a way as to be profitable to the child as well as to be a preparation for adult life, available reading materials and reading activities have been studied and reported. The reading activities and interests of children have been tabulated by numbers of investigators, but the reading activities of adults have been more difficult to determine because of the poor response of adults when questioned.

The greatest need for further investigation lies in the determination of the actual use of scientific concepts to the average adult, for the objective of science teaching in the secondary schools of today is the preparation of average citizens for the ordinary needs of life. The investigators in this field of study have, for the most part, determined the adult reading activities from an impersonal source—they have sought through newspapers and periodicals to note what scientific concepts adults are most likely to need in order to understand the articles contained in such reading material. These studies have been made with the hope of assisting classroom science teachers in their guidance of reading activities into profitable channels. The findings concerning adult reading activities and the materials available for school use can be summarized as follows:

1. Pupils should be prepared in the high school science classes to interpret such science articles as appear in the daily press and standard magazines.

2. At least half of the science articles in newspapers need a background of scientific interest on the part of the reader to yield the most enjoyment and profit.

3. Newspaper articles dealing with science concepts are generally of high standard and reliable.

4. Science articles in newspapers and magazines appear to be more up to date than our high school and college texts.

5. There is a great variety of material available for extensive reading in science.

6. The phraseology of popular articles appeals to young people and is recalled more readily than text-book language.

In experimental classes, procedures for guiding the reading activities in science classes have been worked out and the achievements of pupils in these classes have been found to compare favorably with the achievements of pupils in control groups. Investigators who have conducted these experimental classes report the following findings:

1. Extensive reading plans have found favor with high school pupils—a majority reporting that they found their reading activities more enjoyable and helpful than either experiments or motion pictures.

2. Very few pupils report a dislike for reading.

3. Procedures for reading guidance programs have been used to introduce flexibility into a science course to meet individual needs.

4. The expenditure of funds for extensive reading in the high-school science classes has been shown to be justified by results secured with experimental groups.

Opinions of leading educators should guide directors and teachers who are endeavoring to make profitable changes in their methods of instruction. Evidence collected from books and magazine articles show that many leading educators are sanctioning the more extensive use of the library as the most promising plan for adjusting the teaching in science classes to the needs of the pupil. In this study, books and articles of leading educators were reviewed to find the answers to these questions: (1) Do leading educators recommend a change in high-school science teaching? (2) Are problem situations held appropriate for inducing pupils in secondary-school science classes to search out information? and (3) Is reading guidance a part of science teaching?

SUMMARY OF OPINIONS

The investigator does not claim to have assembled all possible evidence, but feels assured that the references studied are sufficient to show a definite trend in thought. For convenience, an outline sum-

mary of guiding principles gleaned from careful study of these opinions is given here:

1. The main objective of science teaching in secondary schools is preparation for life and not preparation for college.

2. Pupils should be given training in the science classes which will prepare them for meeting the perplexities of life which involve concepts of science.

3. Problem situations aid materially in developing the ability to solve problems.

4. If a desire for explanations is aroused in the pupil he will eagerly search for information.

5. A carefully chosen set of science books and magazines is essential to science teaching.

6. Reading guidance in scientific material should be given by all science teachers in the secondary schools.

7. Study methods which inspire the pupil to read extensively for information concerning science will establish a desire in him for further scientific reading.

8. It is an erroneous thought that the adoption of informal guidance methods necessitates the casting aside of all textbooks.

   a. Textbooks are valuable guides.
   b. New types of textbooks are needed.
   c. The use of supplementary materials with textbooks is more often recommended than extensive reading without a text.

9. The ultimate objective of reading guidance is to build up in the pupil abilities which will give him power to help himself to make opportunities which will bring to him success and happiness.

Regardless of all advice, few classroom teachers will attempt to make changes until a working plan has been furnished them. Therefore, the working plans of those who are trying to adjust their classroom procedures to incorporate recommended changes should be recorded for the benefit of all classroom teachers. Reading guidance plans have been used with such marked success in the science classrooms of the Los Angeles City School System that a careful investigation of their methods might reveal some helpful suggestions. In fact, the work being done in a number of these classes has been so noticeably successful that it inspired the undertaking of this particular study. A total of forty classroom visits were made by the investigator while gathering data on the methods being used in the Los Angeles City Schools. Teachers, principals and supervisors were interviewed; pupils were questioned; and library facilities were noted in the school buildings and in the nearby community libraries.

These interesting methods which inspired pupils to read extensively with apparent enjoyment, led to a desire, on the part of the author, to know more concerning the inception and development of these techniques. The Supervisor of Science Instruction in the Los Angeles School System was very helpful in giving what information he had and in donating course of study materials. Los Angeles School Board Publications were found on file in the library of the University of Southern California—all of which were critically reviewed. Study of the Los Angeles school publications brought to light the fact that their plans for directing reading have been developing through a series of years from a spark kindled by Franklin Bobbitt who, in 1922, made a survey of classroom practices in the Los Angeles Schools and suggested some improvements which might be made. After Bobbitt, came Featherstone with suggestions for a more definite plan which has been worked out by committees of teachers and published under the title, "This Living World" (a teachers' guide for ninth year science).

The most noticeable feature of this plan of teaching being used is that pupils are taught to seek information in various books rather than to learn facts on pages assigned in a single text. Interests are first aroused and the work is planned so that the child feels a need for certain facts which he proceeds to look up in any available books or periodicals. It is surprising to note the variety of source material consulted by these ninth-year youngsters in working out a suggested unit. They are not driven to read a definite number of books assigned—they search through books and magazines until they find what they desire. There

seems to be a joyousness in this search, showing that the goal in view has a pleasing significance. The summing up of a unit of work is made an event of importance to which the pupils look forward.

Sometimes the climax of a study unit takes the form of a play or a group of plays written and worked out by the pupils to illustrate their conception of some phase of the topic just recovered. In one instance the planets in our solar system were shown in their relative positions by costumed children carrying placards. One committee cleverly portrayed the old-time medicine man with his wily schemes to induce the crowd to buy his nostrums. At the close of this little skit the teacher made the remark that although we laugh at the gullibility of the people taken in by the medicine man's line of talk; many, today, run to the drug store to buy some attractively advertised product without making an investigation of its worth. And so, the spark of a new interest was born in the minds of these developing children. Questions were asked and reliable references were suggested. These references were jotted down in notebooks to be read with the purpose of making themselves less gullible in the future.

The "Green Leaf Factory" was being used as a study unit in one of the junior high school classes visited—the idea of the topic being that within a growing green leaf, processes are carried on by nature in much the same way as by the workers in a factory. A trip made to a large bakery was described, by a member of the class, as an example of a modern factory. Certain points were emphasized by the teacher and suggestions were secured from the class to decide upon the elements essential to a factory. A list of these essential elements was placed on the blackboard by a class secretary. At the completion of this group-work an inspirational talk was given by the teacher concerning man's dependence on green leaves. By leading questions and hints of mysterious processes there was built up in these pupils an eagerness to know more concerning this factory run by *Dame Nature*. As a guide to purposeful reading, the teacher suggested that each one make a list of elements essential to the green leaf factory to match the items already listed as essential to the bakery. The list on the board appeared somewhat as follows:

Elements	In Bakery	In Green Leaf
1. Place to work	Buildings	
2. Raw products	Flour, yeast, milk	
3. Water supply	City water supply	
4. Source of power	Burning fuel	
5. Conveyers	Belts and trucks	
6. Fresh air	Fans	
7. Marketable product	Bread, rolls, etc.	

No page references were given and no definite reading requirement was made. The teacher, however, called for volunteer suggestions as to how desired material might be located in books. When all were sure they knew what to do, books were passed out by the class librarian assisted by monitors. Very little time was wasted in getting started although individuals were allowed to make their selections of books. The supervised study period was given over to a search through books for desired information. That their search was being rewarded was indicated by reports to the teacher of page references located, by an eagerness to exchange books, and by diligent work on the outlines.

The examples of the informal guidance method were chosen from junior high school classes because in these schools the method has advanced beyond the experimental stage. Experimental classes have been organized in the senior high schools to try out the informal guidance method for

science instruction. Classes in integrated physical science were the first organized to use the method, but it is now being tried in chemistry, physics and biology classes. In fact, very few teachers were found who are not encouraging the reading of science material outside the single text. In most of the science classrooms some time is given for a student librarian to attend to the withdrawal and return of books. The school libraries were found well supplied with material dealing with scientific concepts and science teachers are making use of the library facilities. However, it must be kept in mind that the reading guidance program is merely one phase of the science class work and that experiments, drills and problems have not been discarded.

No check-up of classroom practices, regarding reading guidance in science, had been made in recent years. Therefore, as a conclusion to this investigation, an attempt was made to determine by means of a questionnaire, the present status of reading guidance in representative science classes throughout the United States. The answers received on the questionnaire, sent to Supervisors of Science Instruction in 144 representative schools in the United States, seem to reveal the fact that reading guidance, although considered a valuable part of science instruction, is not yet widely used in science classrooms. The answers also indicate that various plans for guiding extensive reading in science are being used in experimental classes, though the lack of necessary library facilities for broad reading in science is preventing some science teachers from using methods which require the use of a wide selection of supplementary materials. However, the answers to this questionnaire show an increasing understanding of this type of teaching. It seems evident that progress is being made toward the adoption of teaching techniques which guide pupils into broad reading for desired information.

AN EVALUATION OF CERTAIN POPULAR SCIENCE MISCONCEPTIONS *

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During the last twenty five years the study of unfounded beliefs has captured the interest of many investigators in the field of educational research. Although it has been generally accepted that uneducated persons are handicapped in their thinking and actions by numerous unsound, and even foolish ideas, recent evidence indicates that a large number of superstitions and misconceptions are prevalent among students attending institutions of higher learning. With such findings available, some science teachers are of the opinion that it is the responsibility of science education to more effectively relieve the pupils of these untenable beliefs.

Some unfounded beliefs are called superstitions, while others are called misconceptions, but at times it is difficult to separate them. In this study a misconception was defined as any unfounded belief that does not embody the element of fear, good luck, faith, or supernatural intervention. This definition was used to eliminate from the investigation the common and easily recognized superstitions.

It is not possible, however, to sharply separate all misconceptions from superstitions. Some misconceptions may be considered as borderline cases. To one individual a belief may be a superstition; to another person the same belief, because of fanciful pseudoscientific reasoning, may be a misconception. In general, a misconception

seems to be based on some scientific evidence, rationalization, or cause and effect relationship, whereas, the superstition is entirely devoid of any rational explanation.

In order to illustrate some of the differences between misconceptions and superstitions, several specific examples will be given.

Superstitions:

(a) Embodying the element of fear
   1. Afraid to change a garment immediately after putting it on wrong side out.
   2. Afraid to start on a long journey on Friday the 13th.

(b) Embodying the element of good or bad luck
   1. Finding a four leaf clover brings good luck.
   2. Breaking a mirror brings seven years bad luck.

(c) Embodying the elements of faith or supernatural intervention
   1. The amulet will protect the wearer against evil.
   2. Holy relics and shrines possess miraculous curative powers.

Misconceptions:

(a) Those lacking careful observation
   1. An ostrich will hide its head in the sand when frightened.
   2. Lightning never strikes twice in the same place.

(b) Those lacking the support of established facts
   1. The thoughts of a mother will influence her unborn child.
   2. It is possible to foretell a person's future by studying the stars.

(c) Those lacking the correct interpretation
   1. Summers here are warmer than the winters because the sun is closer to the earth at that time.
   2. Most cases of baldness are caused by wearing tight hats.

It can be seen from the above examples that superstitions have more of an emotional appeal than misconceptions, and that misconceptions are usually the result of faulty reasoning. But the above classification can not be rigidly applied. More than one of these factors may be involved in a single misconception or superstition. A misconception usually results from irrational thinking; a misinterpretation of the cause and effect relationship, whereas, the superstitions are more emotionalized and are less plausible.

It is evident that unfounded beliefs can guide or control a person's acts. It is also evident that some misconceptions could be relatively harmless, while others could lead their possessors into unnecessary difficulties. With which misconceptions should the teacher of science be primarily concerned? Perhaps the most crucial need for remedial instruction in science should be with those misconceptions that have strong possibilities for affecting the behavior of individuals subservient to them.

In an attempt to determine the relative importance of certain popular science misconceptions, the author submitted 292 statements of unfounded beliefs to a group of fifty three experienced science teachers who had been selected on the basis of certain criteria and who had indicated a willingness to help with the study. Any attempt to gather all popular erroneous beliefs would have been a stupendous task, so the list was limited to those misconceptions that seemed to occur frequently in the various sources used for the study.

The misconceptions were collected over a period of three years from high school science classes, science texts, previous studies, popular scientific books, periodicals, newspapers, and the radio. No attempt was made to determine the frequency of occurrence in each of the various sources. The main objective was to obtain a rather extensive list of unfounded beliefs. Only the more common misconceptions, however, were used in the final list. This was an arbitrary selection, based on what seemed to be the relatively popular and widely accepted unfounded beliefs.

In order to substantiate the opinion of the investigator relative to the unfoundedness of the beliefs used, it was thought advisable to refer the items to authoritative sources or scientific publications for verification. Certain misconceptions were verified as such when they disagreed with well established scientific facts or principles. If

this was the case, no further attempt was made to refer the misconception to scientific publications. In many cases the misconception was mentioned in other studies and this was considered sufficiently reliable for its inclusion in this study. It was believed unnecessary to trace back the misconception to the original research.

After a suitable statement was made of each unfounded belief selected, this list of misconceptions was submitted to a jury of expert judges for evaluation. These judges were all experienced science teachers. The science teachers selected for the jury were chosen from (1) a selected list of subscribers to SCIENCE EDUCATION, (2) authors of articles published in recent issues of the same magazine, (3) members of the National Association for Research in Science Teaching, and (4) experienced science teachers known personally by the investigator.

An attempt was made to select science teachers of wide geographical distribution. Science teachers in twenty-five states agreed to evaluate the list of misconceptions. It was assumed that this wide distribution of the judges would tend to minimize the effects of local influences and provincialism in philosophy. It was also assumed that teachers selected from the above groups would represent the more advanced and progressively-minded members of the profession.

The judges were instructed to rate each misconception in the list on a five point scale in accordance with the following code: (1) Very important. (2) Fairly important. (3) Slightly important. (4) Relatively unimportant. (5) Not important. The relative importance of each misconception was to be decided in terms of its potentialities for affecting the behavior of the person subservient to it. That is, a misconception that could influence the behavior of an individual was to be rated as more important than a misconception that had slight possibilities for changing a person's actions.

In order to obtain a composite value for each item, a misconception judged to be "very important" was assigned a value of 1; "fairly important" a value of 2; and so on, with "not important" receiving a value of 5. The several weighted values for each misconception was obtained by multiplying the assigned value by the number of times the statement had been given that rating. The several weighted values a misconception had received were then added to obtain the total weighted value for that statement. Therefore, the item receiving the lowest total weighted value, in the combined opinion of the judges, was considered to be the most important. The one hundred misconceptions receiving the lowest weighted values are given in Table I.

In order to obtain an indication of the extent of agreement among the judges, eight pairs of similar misconceptions were included in the list that was evaluated. These items were scattered at random throughout the list. It seemed logical to assume that a careful evaluation of the misconceptions would result in similar misconceptions receiving similar total weighted values. A comparison of the total weighted values of pairs of similar misconceptions seemed to indicate that the judges used care in their evaluation. The following examples show the close agreement of the judges.

Total weighted value	Misconception
72	Tuberculosis can be inherited.
72	Syphilis can be inherited.
74	The use of certain toothpastes will prevent tooth decay.
76	The use of certain toothpastes will cure pyorrhea.
75	If the teeth are brushed every day they will not decay.
76	For well developed teeth, proper cleaning is more important than diet.
111	Most owls do more harm than good.
114	Most hawks do more harm than good.

Within the limits set by the techniques employed, the writer feels that the findings

TABLE I

ONE HUNDRED MISCONCEPTIONS RANKED IN DESCENDING ORDER OF IMPORTANCE AS SHOWN BY THE COMPOSITE EVALUATION OF FIFTY THREE SCIENCE TEACHERS

Rank (1)	Total weighted value (2)	Misconceptions (3)
1	56	Venereal diseases can be successfully treated at home with "drug store remedies."
2	59	All diseases require drugs (medicine) for their cure.
3.5	61	Syphilis will cure itself if permitted to run its course.
3.5	61	If water is brought to a boil it is sure to kill all bacteria.
5	64	If drinking water is clear, cold, and excellent in taste, it is always safe for drinking.
6	65	Since a child will lose his first set of teeth, it is not necessary to begin dental care until the second set appears.
7.5	66	In order to transmit any disease a person must be actually suffering from the disease.
7.5	66	Children should be exposed to childhood diseases.
10	67	The value of vaccination has been greatly exaggerated by medical men.
10	67	Freezing kills bacteria.
10	67	Cancer can be properly treated by taking patent medicine.
12.5	69	When a person is a licensed optometrist it means he is an eye specialist and is capable of treating any eye disease.
12.5	69	Gonorrhea is no more serious than a bad cold.
14	70	Laxatives should be used by most persons at least once every month in order to clean out wastes that accumulate in the intestines during the month.
15	71	Most bacteria are harmful to man.
17.5	72	Tuberculosis can be inherited.
17.5	72	Syphilis can be inherited.
17.5	72	(*A certain mouth wash*) is very effective for killing germs.
17.5	72	All diseases are caused by tiny living things.
20.5	73	A mild case of scarlet fever can transmit only a mild case to another person.
20.5	73	All men are born with equal physical and mental capacities.
22.5	74	The use of certain toothpastes will prevent tooth decay.
22.5	74	Running water always purifies itself within a few miles.
25.5	75	All mental diseases are incurable.
25.5	75	If the teeth are brushed every day they will not decay.
25.5	75	The wearing of eyeglasses causes one to "get used" to them, hence we should put off using them as long as possible.
25.5	75	Many drugs that act as specific cures for diseases have been discovered.
29.5	76	If the cure for a disease is highly advertised, it usually indicates that scientists have discovered many important facts about the cure for the disease. (Example, common cold.)
29.5	76	All cancers are incurable.
29.5	76	The use of certain toothpastes will cure pyorrhea.
29.5	76	For well-developed teeth, proper cleaning is more important than diet.
33	77	Certain toothpastes are effective germ killers.
33	77	Smallpox vaccination is often more serious than the disease.
33	77	An all vegetable diet is the natural and best diet for all persons.
36.5	78	If a person has enough faith that he will be cured, no other treatment is necessary for any disease.
36.5	78	Malnourished children are seldom found in better class homes.
36.5	78	There are many effective remedies for cancer.
36.5	78	A child begins the formation of health habits when he starts attending school.
40	80	If a person has the title "doctor" it signifies that he has had the same amount of training and education as any other doctor.
40	80	Oculist is just another name for optometrist.
40	80	Girls should avoid all exercise during menstruation.
43	81	Colds can be cured by the use of alkali drinks.
43	81	An effective relief for fatigue is cigarette smoking.
43	81	It is correct to feed a cold and starve a fever.
45	82	When a characteristic is hereditary it will show up in all the offspring in a family.

TABLE I—*Continued*

Rank (1)	Total weighted value (2)	Misconceptions (3)
46	83	A dog is never "mad" unless it foams at the mouth and rushes about in an excited manner.
49	84	Large amounts of cereal roughage should be included in the diet of all individuals.
49	84	Cancer is a contagious disease.
49	84	Highly advertised mineral waters have proved beneficial in the treatment of many diseases.
49	84	Venereal diseases are seldom contracted by members of well-to-do privileged classes.
49	84	The best treatment for tuberculosis is plenty of fresh air and exercise.
53	85	A person suffering from tuberculosis always appears to be weak and run down.
53	85	If a scientist believes something is true, then it is no doubt true.
53	85	If a person wishes to remain healthy it is necessary for him to take doses of medicine occasionally.
56	86	Unpleasant breath can be cured by using certain mouth washes.
56	86	A scientific theory should be, and is, the absolute truth.
56	86	An osteopath is a medical doctor (M.D.) who has specialized in the treatment of bone ailments.
59.5	87	Cigarette smoking is good treatment for nervousness.
59.5	87	Underweight children are always in ill health, or are undernourished.
59.5	87	Only bad or unpleasant odors are dangerous.
59.5	87	In the United States all persons have equal opportunities.
63	88	Many advertised cures for deafness are effective.
63	88	Any person can succeed in any task he undertakes if he has the determination and will power to do so.
63	88	Persons must eat highly advertised foods in order to obtain a sufficient supply of vitamins.
65	89	If more heat is applied to boiling water the temperature goes higher.
67.5	90	A good remedy for snake bite is strong alcoholic drink.
67.5	90	Hydrogen peroxide is an effective germ killer.
67.5	90	Nasal sprays and eye drops can effectively cure hay fever.
67.5	90	Inoculations will prevent the common cold for most persons.
71	91	The scientific soundness of the chiropractor's claims can not be questioned.
71	91	Syphilis is an advanced stage of gonorrhea.
71	91	Malnutrition means not getting enough food.
73	92	The best treatment for weak arches is through the use of well fitted supports.
74.5	93	Information concerning the evils of tobacco and alcohol is usually based on sound scientific investigations.
74.5	93	Acquired characteristics can be transmitted from parent to offspring.
77	94	A mother can influence the character of her unborn child by her thoughts.
77	94	If a woman who is to become a mother is frightened, her child when born will probably bear a birthmark with some resemblance to the cause of her fright.
77	94	To go on a diet always means to eat less.
80	95	Boils are caused by bad blood in the system.
80	95	There is considerable scientific evidence that even moderate smoking is very harmful to all persons.
80	95	If cousins marry, the children will probably be defective.
82	96	It is common practice to disinfect the air in a sick room or lavatory.
83	97	Insanity is sometimes caused by overstudy.
84.5	98	Skin eruptions can usually be cured if one eats yeast regularly.
84.5	98	Ovaltine has special sleep producing powers.
87	99	Masturbation will cause feeblemindedness.
87	99	Measles is most contagious when the skin breaks out.
87	99	Yeast is the only source of certain vitamins.
89	100	Scarlet fever is usually spread by the scales from the skin of the patient.
91	101	Marriages between persons of opposite characteristics and personalities are more liable to be successful.
91	101	Intelligent persons are usually weak physically.
91	101	The great discoveries of science are usually kept secret and sold to "patent medicine" manufacturers.

TABLE I—*Continued*

Rank (1)	Total weighted value (2)	Misconceptions (3)
93.5	102	Drinking whiskey will delay freezing.
93.5	102	If a snake bite is sucked the venom will enter the blood stream through any sore in the mouth.
96.5	103	A drowning person always rises to the surface three times before finally sinking.
96.5	103	Eye exercises are effective for arresting or curing failing eyesight.
96.5	103	Pressing the upper lip or placing a key or piece of ice at the back of the neck are good ways to stop nose bleed.
96.5	103	A cold bath every morning will prevent all illness.
100	104	Colorblindness can be cured with proper treatment.
100	104	Sending a child to bed is a good method of punishment.

in this study seem to warrant the following conclusions:

CONCLUSIONS

A careful evaluation of certain popular science misconceptions by a group of fifty-three selected judges indicated that certain health misconceptions have greater potentialities for affecting the behavior of the believers than the other misconceptions submitted for evaluation.

Also, the misconceptions that were less important as influencers of behavior, in the combined opinions of the judges, were certain misconceptions of purely academic interest, bordering on superstitions, or concerned with natural history.

A STUDY OF LABORATORY APPARATUS IN PHYSICS IN A NUMBER OF FIRST CLASS SMALL TOWN HIGH SCHOOLS IN NORTHWEST MISSOURI

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Interest in effective teaching in the physics laboratory caused the writer to become curious regarding the physics apparatus available for the performance of the experiments required and suggested in the 1927 Missouri State Course of Study. The pertinent question was: to what extent are the laboratories equipped in terms of the recommendations provided by national, state and various supply house laboratory lists?

In small town high schools having limited budgets, is there sufficient apparatus available to provide for the performance of the various experiments required or suggested for individual performance? Is there available sufficient apparatus for demonstration or individual performance of all experiments? If not, for which? If not individually performed, then does the limited apparatus available demand considerable attention to effective demonstration techniques?

The results of a number of studies in the teaching of physics are available on the laboratory versus the demonstration type of lesson or on various phases of the testing program, but seemingly little emphasis has been placed upon the available apparatus to be used by the students in these classes.

THE PROBLEM

This study was undertaken to determine the extent to which the physics laboratories in the small high schools of Northwest Missouri are equipped to perform the

laboratory exercises as recommended by the 1927 Missouri State Course of Study in Physics.[1] An inventory was made of each laboratory in order to determine the amount of apparatus available. These inventories were checked against national lists in order to determine the replacement value. All schools were listed so as to show the number of sets of apparatus available for each experiment as suggested by the 1927 Course of Study. The term set was referred to as the number of pieces of apparatus necessary for performing one experiment. An attempt was made to compare practices and variations which occur in these schools that do not have the suggested apparatus.

PROCEDURES IN GATHERING DATA

The collection of the data was begun during the first part of January and finished about the first day of May, 1938. These data were taken from thirty of the thirty-two first class high schools in the Northwest Missouri district whose enrollment did not exceed three hundred students and who offered physics in the program of studies. First class high schools are defined as four-year, fully accredited state institutions. High schools having a larger enrollment were not considered because experience shows that they possess, or at least they have the opportunity to possess, more adequate equipment to care for the comparatively few students who take this subject.

The Northwest Missouri district is strictly an agricultural region and is composed of nineteen counties situated in the northwestern part of Missouri. This territory is about eighty miles long and ninety miles wide.

The task of collecting these data was done by the checklist, questionnaire, and visitation methods. The latter method was employed in gathering data from those schools which were advantageously situated. About thirty-five per cent of the data was collected by this method. A mimeographed checklist and questionnaire was sent to all of the schools not personally visited. With two exceptions, information was received from all schools that had offered physics during the 1937–1938 school year. The checklist was prepared from the list of recommended equipment and apparatus in the 1927 Missouri State Course of Study in Physics. To standardize the list, a check was made on the apparatus as recommended by this course of study with the supply catalogues made available by the Central Scientific Company, Chicago, Illinois; W. M. Welch Manufacturing Company, Chicago, Illinois, and A. C. Monahan's Bulletin No. 22, Laboratory Layouts for the High School Sciences, Bureau of Education, Washington, D. C., 1927. The result showed it to compare very favorably with their recommendations.

LIMITATIONS AND ASSUMPTIONS OF THE STUDY

The limitations of the study are apparent, because the various schools represented in this study may be able to set up experiments not required by the Missouri State Department of Education and these might have a worthwhile place in the daily assignments.

There arose situations in which it was necessary to make rather arbitrary decisions. In each case, however, such decisions were made only after consideration of all available facts.

TREATMENT OF DATA

The fifty-three experiments as suggested by the syllabus, hereafter referred to by number instead of by title, are classified as follows:[2]

[1] State of Missouri. *Science Syllabus*, Bulletin No. 7, 1927, pp. 129–130.

[2] *Ibid.*, pp. 129–130.

A. Experiments to be Performed Individually or in Small Groups

Exp. No.	Title
1.	Measurements, Linear, Volume, Mass.
2.	Density of Solids.
3.	Specific Gravity of Liquids.
4.	Hooke's Law.
5.	Composition and Resolution of Forces.
6.	The Pulley, Block and Tackle.
7.	The Inclined Plane.
8.	The Lever.
9.	Laws of the Pendulum.
10.	Specific Heat.
11.	Determination of the Boiling Point.
12.	Heat of Fusion of Ice.
13.	Heat of Vaporization of Water.
14.	Laws of Vibration Strings.
15.	Image in a Plane Mirror.
16.	Index of Refraction of Glass.
17.	Focal Length of Concave Mirror.
18.	Lines of Magnetic Induction.
19.	Field about a Permanent Magnet.
20.	Study of the Voltaic Cell.
21.	Magnetic Effect of an Electric Current.
22.	Study of the Electro-Magnet.
23.	Magnetic Effect of Coils Carrying a Current.
24.	Laws of Resistance.
25.	Ohm's Law.

B. Experiments to be Demonstrated

26.	Weight of Air.
27.	Linear Expansion of Metals.
28.	Expansion of Gases.
29.	Study of Compound Microscope.
30.	Study of the Telescope.
31.	Study of the Electric Generator.
32.	Study of the Electric Motor.
33.	Study of the Transformer.
34.	Study of the Telephone.
35.	Study of Telegraph Instruments.
36.	Study of Radiations.
37.	Study of Radio.

C. Experiments to be Performed Individually or by Demonstration

38.	Boyle's Law.
39.	The Wheel and Axle.
40.	Study of Thermometers.
41.	Determination of the Dew Point.
42.	Mechanical Equivalent of Heat.
43.	Velocity of Sound.
44.	Wave Length of Sound.
45.	Image Formation Through Convex and Concave Lens.
46.	Magnifying Power of a Simple Lens.
47.	Study of Photometer.
48.	Static Electricity.
49.	Electromotive Force.
50.	Internal Resistance of Batteries.
51.	Study of Induced Currents.
52.	The Fall of Potential Along a Conductor.
53.	The Heating Effect of a Current.

The various pieces of apparatus necessary to perform the experiments were arbitrarily chosen after an examination of leading high school physics manuals. The writer, having had eleven years of experience in the teaching of Physics, felt capable of choosing the pieces of apparatus necessary for each experiment. It is possible that, in some instances, other pieces would have worked as advantageously but, taken as a whole, this is of little significance in this study.

A work chart was made on which was noted the number of sets of apparatus each school had available for each experiment.

It will be noted that the first twenty-five experiments are to be performed individually or in small groups. Experiments twenty-six to thirty-seven are demonstrations and from thirty-eight to fifty-three are to be done either individually or by demonstration. Of the fifty-three experiments, twenty-eight of these may be done by demonstration.

Findings by Schools

These data were tabulated, analyzed, and carefully studied both in terms of school and also in terms of experiments. A compilation of these data is to be found in Tables 5 to 34 and 35 to 87, of the complete study of which this is an abstract. In each of the first thirty tables, physics apparatus for each school is analyzed in terms of the class enrollment in physics. Each table shows the number of sets of apparatus available for each experiment; the minimum class grouping in order to accommodate the class, working simultaneously and also whether or not in terms of apparatus available; the particular experiment can be demonstrated or performed individually. The coverage per cents are also shown for each experiment. The percentages of coverages may be defined as that percentage of the class which can individually be supplied with apparatus in order to work the experiment. This is found by dividing the number of students

in the class by the number of available sets and expressing the decimal as a per cent.

FINDINGS BY EXPERIMENT

Tables 35 to 87 show a comparison by schools of apparatus for each of the fifty-three experiments. In each of the following tables the schools are listed vertically. The average enrollment, number of sets of apparatus, per cent coverage, minimum number in each group for each experiment, demonstration experiment and individual experiment are listed horizontally.

PRACTICES AND VARIATIONS

As it has been previously stated, those schools that did not have the apparatus to perform the suggested experiments, either omitted the experiment altogether, modified it by performing a similar experiment, or bringing apparatus from outside the school in order to demonstrate the principle.

One school did not have hydrometers or a specific gravity bottle to be used in the experiment on Specific Gravity of Liquids and Solids. The principle involving the

TABLE 1

SUMMARY OF TABLES 5–34

School	Avg. Enroll.	Available Apparatus Sufficient: To Perform (n) Exps. Indiv.	To Perform (n) Exps. in Groups of 2	3	4	5	6	7	8	To Perform (n) Exps. by Dem.	App. not Available for (n) Exps.
A	10	2	0	12	0	11	0	0	25	49	2
B	16	0	3	1	2	3	0	0	33	42	11
C	20	0	7	4	0	5	5	0	25	50	3
D	20	0	5	2	5	2	4	0	30	48	5
E	20	0	1	2	0	0	0	0	39	44	9
F	25	1	1	1	0	0	3	0	42	49	4
G	18	4	3	11	3	0	9	0	12	51	2
H	12	0	3	4	3	0	7	0	22	41	12
I	20	1	0	0	0	0	2	0	37	40	13
J	15	0	0	2	0	1	0	5	16	27	26
K	12	0	11	9	8	0	5	0	12	48	5
L	12	0	3	7	3	0	16	0	15	47	6
M	15	0	5	10	0	2	0	10	12	43	10
N	17	0	8	0	4	6	0	0	26	47	6
O	6	12	0	8	0	0	14	0	0	42	12
P	14	0	1	1	1	1	0	6	17	31	22
Q	9	2	6	0	7	0	0	0	25	48	5
R	7	0	6	10	0	0	0	22	0	40	13
S	16	0	5	0	0	4	0	0	34	44	9
T	17	0	0	1	0	2	0	0	45	48	5
Y	12	1	1	2	3	0	12	0	20	39	14
V	12	0	4	3	1	1	12	0	24	46	7
W	17	0	0	1	0	2	0	4	27	35	19
X	9	1	1	5	5	0	0	0	11	24	29
T	15	1	0	0	0	6	0	7	18	33	20
Z	12	0	0	2	1	0	3	0	36	43	10
AA	15	0	0	2	0	3	0	7	17	29	24
BB	12	1	5	1	8	0	6	0	20	45	8
CC	8	0	8	0	7	0	0	0	28	47	6
DD	21	0	0	0	1	2	0	1	23	37	16

Read as follows: School A, average enrollment in physics of 10 pupils, has sufficient apparatus available to perform 2 experiments individually; has sufficient available apparatus to perform experiments in groups as follows: None in groups of 2; 12 in groups of 3; none in groups of 4; 11 in groups of 5; none in groups of 6 or 7 and 25 in groups of 8 or more. Forty-nine experiments can be demonstrated. It does not have available apparatus for the performance of 2 of the 53 recommended experiments.

TABLE 2

SUMMARY OF TABLES 35–87 OF APPARATUS FOR 53 EXPERIMENTS IN THE MISSOURI STATE COURSE OF STUDY IN PHYSICS

Exp.	Avg. no. sets	Avg. % coverage	Group Range	No. Yes	Dem. No	No. Ind.	No. Group	No. Equip.
1	1.8	14.	0–20	25	5	0	25	5
2	1.9	12.6	0–20	29	1	0	29	1
3	1.1	7.6	0–20	23	7	0	23	7
4	4.5	36.2	1–17	30	0	1	29	0
5	1.5	10.5	0–21	23	7	0	23	7
6	2.1	15.6	0–21	23	7	0	23	7
7	1.5	11.5	0–21	28	2	0	28	2
8	3.9	26.	0–21	28	2	1	27	2
9	3.4	25.	0–16	23	7	2	21	7
10	1.7	13.6	0–21	25	5	0	25	5
11	1.9	14.2	0–21	23	7	0	23	7
12	1.9	11.1	0–21	26	4	0	26	4
13	1.4	10.4	0–21	22	8	0	22	8
14	.7	5.2	0–25	22	8	0	22	8
15	2.1	18.	0–25	24	6	1	23	6
16	2.	16.1	0–25	26	4	1	25	4
17	.7	5.4	0–25	20	10	0	20	10
18	.9	7.	0–25	17	13	1	16	13
19	10.7	62.4	0–21	29	1	8	21	1
20	1.7	14.3	0–25	20	10	0	20	10
21	4.1	32.5	0–25	29	1	2	27	1
22	4.5	36.8	0–25	29	1	1	28	1
23	2.4	18.9	0–25	29	1	0	29	1
24	1.1	8.	0–25	24	6	0	24	6
25	1.1	8.	0–25	24	6	0	24	6
26	2.3	17.5	0–21	25	5	0	25	5
27	1.4	12.2	0–25	22	8	0	22	8
28	4.2	33.	0–20	28	2	1	27	2
29	1.6	12.8	0–20	22	8	0	22	8
30	1.6	12.3	0–20	23	7	0	23	7
31	1.4	10.6	0–20	27	3	0	27	3
32	1.5	11.9	0–21	29	1	0	29	1
33	.3	3.	0–21	11	19	0	11	19
34	.6	5.	0–25	19	11	0	19	11
35	.7	5.6	0–21	20	10	0	20	10
36	.2	1.4	0–20	6	24	0	6	24
37	.4	3.5	0–20	14	16	0	14	16
38	.9	6.8	0–25	22	8	0	22	8
39	.9	6.5	0–25	22	8	0	22	8
40	4.	29.5	0–21	28	2	2	26	2
41	4.8	31.8	0–21	29	1	1	28	1
42	1.6	12.	0–20	24	6	0	24	6
43	1.	8.6	0–25	25	5	0	25	5
44	1.1	8.4	0–25	24	6	0	24	6
45	3.1	23.2	0–21	20	10	0	20	10
46	3.7	27.6	0–20	26	4	2	24	4
47	.7	5.9	0–20	21	9	0	21	9
48	1.6	12.1	0–21	29	1	0	29	1
49	1.	8.2	0–25	24	6	0	24	6
50	1.9	15.7	0–25	21	9	0	21	9
51	1.2	8.7	0–25	25	5	0	25	5
52	1.1	8.6	0–25	26	4	0	26	4
53	1.3	9.5	0–21	25	5	0	25	5

Read as follows: Experiment 1 has an average number of 1.8 sets of available apparatus; an average per cent coverage of 14 and a group range of 0–20. Twenty-five schools can demonstrate this experiment; 5 schools cannot demonstrate; no schools can perform individually; 25 schools must perform the experiment by working in groups and 5 schools do not have apparatus available to either demonstrate or perform the experiment individually.

specific gravity of solids was shown by using a graduate, water, a piece of rock and laboratory balances. The weight of the rock in grams was known. The mass of the rock divided by the volume of water in cubic centimeters it displaced gave the density of the substance. The principle of specific gravity of liquids was demonstrated to this same class by using an anti-freeze hydrometer which was borrowed from a garage owner.

Hooke's Law was demonstrated in some instances by using screen door springs and placing them under various tensions.

Laboratory pulleys were not available in some schools. Students of a few schools brought in wire stretchers and a builder's jack screw. The situation developed into a very practical one for these rural boys and girls.

The experiment dealing with the lever was almost always carried on by having some students bring such articles as nut-crackers, wrecking bars, scissors and ice tongs. The experiment in many instances could be done individually. At least the laws of levers could be demonstrated from a practical standpoint. One school used a hydraulic car jack to demonstrate the principle of levers and also the principle of liquids under pressure.

Sonometers are rather rare pieces of apparatus in the small high school. One school reported that the laws of vibrating strings were demonstrated by stretching a number of 24 copper wire across the top of a table and using the table top as a sounding board.

The recommended list of apparatus called for the student type of demonstration cell for the experiment on the Voltaic cell. Fifteen schools made their own by using sulphuric acid and copper sulfate as an electrolyte and metals such as lead, zinc, carbon or copper as the anode and cathode. This procedure should be acceptable in any high school physics laboratory.

The study shows that the schools were in a great number of instances deficient on apparatus for performing experiments in light. Twelve schools reported that they partially or wholly substituted the optical disc exercises in lieu of the light experiments. The compound microscope was examined in one instance where the school did not have the required lens to perform the experiment on magnification. A broken plane mirror was also used to show the different colors of the spectrum.

Some classes made trips to their local telephone exchange if there was a shortage of apparatus for the experiment on the telephone.

Two schools reported trips to the depot in order that they might become familiar with the principles of telegraphy. One school reported that a telegraph sender and receiver was made as a class project.

It is very doubtful whether the average instructor in high school physics has been able to keep up with the rapid development in radio. Ordinarily the principle of the radio tube is at least demonstrated. In one case a local radio shop man was invited to come to the physics classroom and give a talk on the elementary phases of the subject.

The experiment involving the determination of the weight of air was performed in one school by first weighing a deflated football bladder and then after inflating, reweighing the same. The difference in weight caused by inflating the bladder was noted as the weight of air.

Primary and secondary coils used in direct current experiments were supplied in three cases by using the coils from T model Ford cars. By using a half-dozen dry cells attached to one of these coils, enough current is produced when attached to a vacuum Guinea and Feather tube to make a striking demonstration on electrical radiations.

An interesting substitute experiment on the velocity of sound was reported by three schools. A distance of a quarter of a mile was measured off on the railroad track.

One of the students at one end of the distance would clap two boards together and another would drop a handkerchief at the same time. A student at the other end of the distance would start a stop watch at the instant the handkerchief left the student's hand and would stop it upon hearing the sound. The experiment, although possibly not as accurately done as with the use of the vibrograph or tuning fork and resonance tube, did prove within reason the velocity of sound in air.

It is comparatively difficult to perform the experiment on the heating effect of an electric current unless the current is constant. One school showed qualitatively the heating effect by short circuiting a common dry cell battery. The only other school to report any variation on this experiment stated that a lighted sixty watt bulb was immersed in water to within a quarter of an inch of the socket. The rise in temperature of the water was noted and by applying the formulae, $H=.241^2rT$, a reasonable answer was obtained.

An instructor or student should be highly commended who has initiative enough to provide substitutes for the suggested experiments because of the lack of sufficient apparatus. It at least shows an attempt to do that which is recommended.

Rural students who have an understanding of the simple laws of physics that are applied in their immediate environment will no doubt appreciate the fact that physics plays just as an important part in their lives as it does in the lives of the students of urban areas.

By way of slight deviation, it might here be noted with considerable interest that a majority of the thirty schools spent less than $50.00 during the preceding 12 months while one school spent $250.00. The reason for the purchasing of such a small amount of apparatus is no doubt due to the very marked retrenchment program that schools have had to adopt in the past few years.

No school was provided with a motor generator set for supplying direct current. Every school with the exception of one had available alternating current. Even though it was available the classes could make little use of it because of the lack of A. C. apparatus. Every school indicated the presence of direct current. The source of this current was dry cells, storage batteries or six volt power units. There is no fault to find in using dry cells with the exception that they do not supply a steady current.

Twenty-two schools were supplied with running water. In most cases there was only one faucet in the laboratory.

Five schools were equipped with gas. The remaining schools reported that they used blow torches, alcohol burners or electric hot plates as sources of heat.

No school was equipped with compressed air.

One school charged $2.00 as a laboratory fee. No part of this was returned at the end of the school year. This fee is used to replace broken apparatus or to buy new pieces in case there is a balance in the fund at the close of the school year.

The average number of pupils taking physics in all schools was 14.4. Eighteen of the schools offered physics every year. Three schools alternated with chemistry. Biology was used as an alternate subject with six schools. One school indicated that eight students had to enroll in the course before it would be offered. Advanced mathematics and physical geography were alternated with physics in two schools.

SUMMARY AND CONCLUSIONS

Finally, the significance of the study resolves itself into the following specific and conclusive paragraphs:

1. These schools are very poorly equipped to do the individual laboratory exercises as recommended.

2. Practically all laboratory work is carried on by demonstration or in large groups.

3. Including the practices and variations as indicated by those schools making reply, the demonstration work is very satisfactory.

4. There is a trend toward biology as a substitute for physics, especially in the smaller schools. This is due possibly to two factors: first, the cost of equipping a physics laboratory for individual instruction would be almost prohibitive due to limited funds, and second by alternating biology with physics, part of the apparatus would be in use each year.

5. Future purchases of apparatus should be made with the idea of building up the laboratories to the extent that the first twenty-five experiments as recommended by the 1927 Missouri State Course of Study in Physics can be individually performed. This is especially true in the case of heat, light and electrical experiments.

6. No definite plan seems to have been followed in the purchase of apparatus.

7. From the various interviews conducted by the writer, it is evident that where the schools do not have the apparatus for performing the laboratory exercises, the science teachers are putting forth their best efforts to relieve this situation by substituting other experiments involving the same physical principle and by class visitation to such places as power plants, garages, telephone exchanges, ice plants and depots.

8. From this study it is recommended that where the schools do not have the necessary apparatus to perform the experiments individually, the instructor should be constantly alert to the fact that by the improvement of his laboratory techniques, the demonstration method of laboratory procedure can be made to be a very effective method in the teaching of physics.

9. Students should be encouraged to bring apparatus to the physics classes that would in any way demonstrate a principle or principles involved in the lesson assignments.

10. The reading of scientific magazines is to be encouraged, as these magazines are good sources of practical experimental physics. A majority of the students in these classes will not attend college or university but will continue to live in the small towns or on the farm. There can be no other alternative but to make the physics laboratory classes as practical as possible. If there are students in these classes who are likely to make a more advanced study of science, they should be allowed to demonstrate a part of the work in order to learn the various techniques necessary in the manipulation of scientific apparatus.

A CHALLENGING PRETEST

WALTER A. THURBER
Ithaca, New York

The following pretest introduced a unit on local geology in two eighth grade science classes in the Ithaca Public Schools. The success of the pretest, as measured in terms of interest and intelligent discussion, seems to warrant more extensive use of its type.

The questions were not designed to test informational background, but to challenge imagination. However, as pupils discussed the questions they gave a good picture of their personal experiences and their store of local traditions and prejudices. A pretest made up of "bookish" questions rarely causes such discussion.

Changes were emphasized by the pretest, particularly changes that the pupils could verify by personal observations or by asking older people. The geological features which were considered were prominent and well-known to all the pupils. It was interesting to note the effect of suggestions that such supposedly permanent features could change, although the pupils could usually

recall small changes that they had noticed personally.

After the pretest was given, a summary of class opinions was made on the blackboard and discussion was begun on the first question. The discussion lead into the first topic, local stream erosion. New topics were introduced by reference to related questions in the pretest.

Ideally, the test should have been given at the end of the unit to call attention to changed concepts but lack of time prevented this.

WHAT DO YOU BELIEVE?

Which of the following statements do you believe to be the most probable? Mark those you think probable with a plus sign, those you do not believe with a minus sign.

I. Cascadilla Gorge
———1. has always been as deep as it is now.
———2. is being dug deeper every year.
———3. was once a much smaller gorge.
———4. was dug out by a glacier.

II. Enfield Glen
———1. was changed by the last flood.
———2. is cut from rocks that were once mud and sand.
———3. would be deeper if the bands were of clay.

III. Cayuga Lake
———1. is filling up.
———2. may some day disappear.
———3. cannot change.
———4. was here at the beginning of the world.
———5. is a dammed-up river valley.

VI. Ithaca is built
———1. on soil that came from nearby hills.
———2. on soil that came from Canada.
———3. on a delta.
———4. on soil carried here by man.

V. The airport is built
———1. upon a natural plain.
———2. upon a swamp.
———3. upon part of the lake.
———4. upon soil brought in by man.

VI. The site of the Cornell Campus
———1. was once beneath the sea.
———2. was once covered with ice and snow all the year.
———3. has moved up and down.

VII. The salt mines
———1. contain salt hidden by early men.
———2. are connected with salt water of the sea.
———3. contain salt from a dried-up salt lake.

VIII. The cement plant was built at Portland Point because
———1. there is plenty of water.
———2. there is salt.
———3. there is limestone.
———4. there is a view.

CONTRIBUTION OF THE SUMMER CAMP TO A GENERAL SCIENCE COURSE *

JAMES G. HOLLANDSWORTH
Berwind Junior High School, Berwind, West Virginia

The problem of this study was to show how much of a general science course the camper may contact through normal camp activities in a progressive summer camp. Since the general science course is educationally valuable, and if the camp makes some contribution to this course, it may be logically concluded that the progressive summer camp is also educationally valuable.

The particular type of camp chosen for study was the private camp for boys, a financially self-sustaining camp owned by an individual or a group of individuals. Furthermore this study dealt with a camp based on the progressive philosophy of camping, that is, the camp has the following characteristics:

In a camp following the progressive philosophy of camping the boy is not assigned to classes and activities but participates as he desires. The boy enters into activities because they are attractive and interesting rather than compulsory. He is motivated by interest.

* Based on Master's Thesis, 1938. George Peabody College for Teachers, Nashville, Tennessee.

Extrinsic motivators have little value and possibly a negative value in opening the boys' eyes, ears, and mind to the real situations in which he lives. A far better means of motivation is to create within the boy a need to accomplish something that he believes is valuable. Possession of that "value" and the attending satisfaction that goes with possession is more prized than buttons, banners, and medals.

In the child-centered camp program the more mature and experienced men are the cabin counselors who live in direct contact with the boys rather than being the activity directors and teachers of skills. Cabin leadership is their first responsibility, with skills and activities secondary. It is the duty of the counselor not merely to give the boy training in certain activities and subject matter but also to live with the boy and influence his whole personality.

To be of greatest value it is necessary that the boy should have a long uninterrupted stay in camp. While the camp for a week or two in duration is recreationally valuable, the educational returns are slight. It requires a much longer time than two weeks to influence the boy's personality and character and in addition to give him usable information and knowledge. To carry on a free-choice, non-award, and child-centered program the progressive camp keeps the boy from six to twelve weeks and charges a fee ranging from $150. to $300. for the season.

In order to provide real situations the camp must be sufficiently isolated from organized society to place the boy on his own responsibility. There are some things in organized society which will enrich the camp life of the boy, but the highly commercialized and mechanized civilization which is about him all winter should be excluded. The boy must do his own living. It is the meeting of his own problems in this real situation that vitalizes learning to the camper.

The program of Camp Sequoyah, a representative progressive private camp for boys, was the camp chosen for this study. Camp Sequoyah was founded in 1924 by C. Walton Johnson who still directs the camp. It is located sixteen miles northwest of Asheville, North Carolina, in the Craggy Mountains. The camp is equipped for one hundred and twenty-five campers and thirty-five counselors. The Sequoyah plant comprises one hundred and twenty-five acres, forty buildings fully equipped, a complete water system, an electric light system, athletic field, lake, rifle range, two riding fields, two council rings, outdoor theatre, Indian village, and four tennis courts. The ages of the campers range from eight to eighteen.

The objectives of the camp are:

1. To give the camper knowledge and usable information.
   a. To improve his old skills.
   b. To give him new skills, interest, and avocations.
   c. To give him facts that may be used in school.
2. To develop the camper's thinking power.
   a. To improve his ability to discover and define problems.
   b. To improve his ability to observe phenomena accurately.
   c. To improve his ability to select facts pertinent to a problem.
   d. To improve his ability to collect and organize facts.
   e. To improve his ability to draw inferences from facts.
   f. To improve his ability to plan experiments to test hypotheses.
   g. To improve his ability to apply facts and principles to new situations.
   h. To develop his scientific attitude.
3. To adjust the camper emotionally.
   a. To aid his behavior adjustment.
   b. To develop his self-respect.
   c. To improve his ability to face reality.
   d. To improve his ability to accept responsibility.
4. To adjust the camper socially.
   a. To improve his ability to work harmoniously with others.
   b. To develop his social sensitivity.
5. To improve the camper's tastes and appreciations.
   a. To improve his appreciation of art, literature, music, and nature.
   b. To improve his self expression.

c. To increase his ability to keep himself and surroundings neat and attractive.

6 To improve the camper's physical health.
   a. To improve his health by consideration of proper gain in weight, relaxation and sleep, posture, neuro-muscular responses, exercise, and health habits.

7. To give the camper spiritual growth.
   a. To aid him in forming and understanding a self-created religion.

The general science course referred to in this study was the orientation course taught in the junior high school which usually is offered in the seventh, eighth, or ninth grade, or possibly extends through all of these. In these grades the boys are between twelve and sixteen years old, the age at which most of them attend summer camps.

One state course of study was analyzed to find the objectives and subject matter of general science that may be contacted through normal camp activities. This course of study [1] is for the seventh, eighth and ninth grades of junior high schools in the state of Pennsylvania. It was chosen after surveying the annual lists compiled by the Society for Curriculum Study [2] of the most outstanding courses of study of that year.

From this list, several courses were evaluated by criteria and forms of Caswell and Campbell,[3] and Stratemeyer and Bruner.[4] Guided by the evaluation and nature of the course, the Pennsylvania state course of study was found to best fit the purpose of the study.

The objectives of the Pennsylvania state course of study are stated in the following outline:

[1] *Course of Study in Science for Grades Seven, Eight and Nine,* Department of Public Instruction, Commonwealth of Pennsylvania, Harrisburg, 1933, Bulletin 73.

[2] H. B. Bruner and Maurice Wieting, "Annual List of Outstanding Courses of Study," *Curriculum Journal,* VII (1936), 14.

[3] H. L. Caswell and D. S. Campbell, *Reading in Curriculum Development* (New York: American Book Company, 1937), pp. 690–692.

[4] F. B. Stratemeyer and H. B. Bruner, *Rating Elementary School Courses of Study,* New York: Bureau of Publications, Columbia University, 1926, pp. 107–112.

OBJECTIVES OF SCIENCE IN JUNIOR HIGH SCHOOL YEARS

A. Knowledge
   Of man's increasing ability to control his whole environment.
   Of the social problems that arise as a result of this increasing control.

B. Abilities, Habits, and Skills
   The ability to discriminate between truth and "half-truth."
   The ability to find truth by direct observation of nature, including the results of simple experiments. This is training in scientific method.
   The ability to devise simple experiments to aid in solving problems.
   The habit of care in handling apparatus and materials.
   The habit of a worthy use of leisure.
   Skill in observation.
   Skill in recording results.
   Skill in drawing conclusions.

C. Attitudes
   A keen interest in nature.
   A spirit of inquiry.
   Suspending judgment in the absence of facts.
   Tolerance.

From this progressive private camp for boys and from this junior high school general science course data which had a bearing on the problem of this study were collected.

METHOD OF STUDY

The activities of the summer camp were analyzed to point out ways in which they contribute to the science course through a background of experiences and activities for work in general science. In the camp the boy is brought into direct personal contact with the situations from which scientific principles arise. He must also use the information he gains in meeting problems some of which have been solved for him by others at home and school. The camper learns woodcraft and campcraft because he must care for himself in the open, find his way when lost, feed himself, and keep warm without shelter. He must learn about his environment and how to control it, not for the purpose of passing written or oral tests, but for passing more practical tests of his ability to provide for his own comfort, pleasure, or endurance. Thus camping as

a whole, the living out-of-doors, is living in a real situation. This real situation is vitalizing the background of scientific knowledge and usable information that the camper is obtaining. Twenty-eight of the forty-five chief activities of the camp were described since they definitely contribute to a background for general science. The amount of contribution was pointed out in these descriptions.

Since the Pennsylvania course of study was divided into units for the seventh, eighth, and ninth grades some overlapping material appeared. From a study of each unit a complete list of topics for the three years was obtained and duplicating material collected into twenty-one units. No subject matter was omitted. Under each unit appear various topics which were paralleled with activities in the camp.

To illustrate this procedure consider the first topic, "Harmful Insects," under Unit I. In the general science course a study of harmful insects may include such activities as:

1. An insect field trip.
2. Mounting specimens.
3. Drawing of insects showing features and characteristics that make them harmful.
4. Reading about insects in the school library.
5. Reports on harmful insects.
6. Study of methods to exterminate harmful insects.

In the nature-lore program of the summer camp a study of harmful insects may include such activities as:

1. An insect ramble.
2. Mounting specimens.
3. Drawing and descriptions of insects for a camp notebook.
4. Reading about insects in the camp or nature den library.
5. Scout reports or various harmful insects for cabin group meetings, campfire programs, camp paper, and talking with counselors and fellow campers.
6. Extermination of harmful insects about camp.

Since these activities parallel each other it is assumed that this general science topic may be learned or may receive a background in the summer camp.

Each topic of the general science course was studied in this manner.

TABLE I

CONTRIBUTION OF THE SUMMER CAMP TO A GENERAL SCIENCE COURSE

Name of Unit	Number of Topics	Number Contacted in Camp	Number Not Contacted in Camp
1. Exploring Nature	15	15	0
2. The Earth's Crust	14	10	4
3. Fire—Friend and Foe	11	9	2
4. Heat	14	12	2
5. Stars and Solar System	22	18	4
6. Magnetism and Electricity	8	6	2
7. Making Use of Water	13	9	4
8. Flowers and Plants	25	25	0
9. Gardening	7	5	2
10. Plant Products and Forests	19	17	2
11. Sound	6	1	5
12. Modern Communication	5	4	1
13. Modern Transportation	4	3	1
14. Things and How Moved	13	8	5
15. Air and Weather	11	7	4
16. Characteristics of Living Things	18	11	7
17. Common Elements and Compounds	16	10	6
18. Light	10	5	5
19. Measurements and Calculations	3	1	2
20. Plants, Animals and Man	22	16	6
21. Man and His Environment	9	5	4
Total	265	197	68

Percentage of total number of topics contacted in the camp—74.34%.

Each objective of the general science course was studied to find camp objectives that might assist in attaining that science objective.

Modern educational institutions state their goals as objectives to be attained. However, the actual results of the educational process are designated as outcomes. The summer camp, as a modern educational institution, also states goals in terms of objectives and results in terms of outcomes.

The outcomes of education should not be assumed. An elaborate system of testing has been devised to measure these results. Likewise the progressive summer camp

cannot assume its objectives are accomplished so the study was concluded with a group of suggested methods of testing outcomes of the summer camp.

Conclusions

1. The objectives of a general science course are included in the objectives of the progressive summer camp, therefore the attainment of the summer camp objectives would tend to indicate attainment of the general science objectives.

2. Certain evaluation methods should be used to measure camp outcomes. This testing would indicate in part the contribution of the summer camp to various school subjects.

3. Camp offers a wide background of experiences for a general science course through 62 per cent of its activities.

4. In a general science course 75 per cent of the topics were found in normal camp activities.

Since 75 per cent of the general science topics, a wide background of general science experiences, and the desirable objectives of general science appear in the normal activities of a progressive summer camp, it may be concluded that the summer camp definitely contributes to a general science course.

Classroom Notes

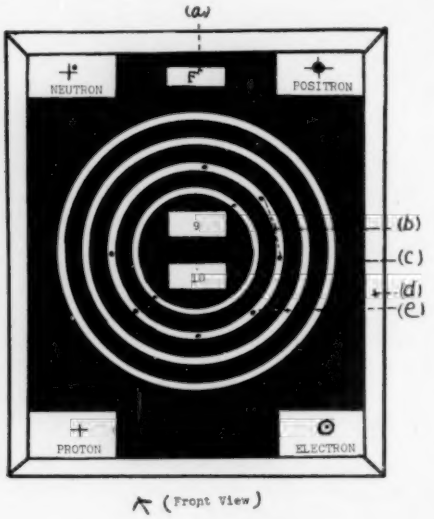
A New Atom Model.—Dalton's atomic theory was the basis of most of the developments of chemistry during the century after its enunciation.

The determination of the relative weights and the combining powers of the different atoms absorbed the interest of the analytical and inorganic chemist. In the same sense that the architecture of the molecule was the outstanding problem of the nineteenth century, the architecture of the atom is one of the outstanding problems of the present century. Certainly it is the most fundamental field of science for in it is bound the understanding of all the physical and chemical properties of all forms of matter.

When Dalton showed that the concept of atomism served to explain the behavior of chemical elements in their combinations and reactions, he brought the atomic theory into the field of science.

In the hands of the chemist it has led to the atomic models of Lewis and Langmuir, Kossel and others, which have clarified our ideas of valence and the properties of the elements.

In order to convey to the students of Chemistry a clearer mental picture of the arrangement of the atom we have constructed an instrument to show the concepts of the atomic structure and to make clearer the postulates of many theorists of atomic models.



Atom Model (Front View)

(a) Symbols of Element; (b) movable disks—electrons; (c) black paper; (d) wooden frame; (e) planetary rings.

The instrument, which is rectangular in shape, is 28 inches horizontally, 32 inches vertically and 6 inches deep. The back and sides are constructed of wood. The front or face of the instrument is glass.

In the remainder of the article we will refer to the front section as Section Number 1, and the back section as Section Number 2.

Section Number 1 is constructed of double strength window glass and a wooden frame, to hold glass, which is made from 2½" x 1" material.

On the back side of the glass is placed white tracing paper. On this paper are ruled wide dark lines as orbits, showing the position of the planetary rings. This resembles a target as used in archery. Between the dark lines no ink appears, thus giving a transparent surface which resembles frosted glass.

In the center of the glass of Section Number 1, inside of the first planetary ring, two small rectangles were not painted black which affords a place to show the number of protons and neutrons necessary in the element under discussion.

The method of controlling the proton and neutron numbers will be discussed later in the article.

In each outside corner of Section Number 1, that is, outside of the planetary rings, are placed diagrams of the proton, neutron, electron and positron symbols. Near the top of Section Number 1, just above the planetary rings, is another small rectangular space, not painted, which affords a place to show the symbols of the element under discussion in a classroom. The method of controlling the elements roll will be discussed later in the article.

Section Number 2 is a box like construction made from 5" x 1" sides and ¼" plywood for the back. There is also a ¾" x 27" x 31" plywood board placed as a center panel in Section Number 2, thus allowing a little better than 2" space on each side of this panel.

On the side of the center panel near the front, orbits are marked so as to line up with the planetary rings of Section Number 1. Now between these orbits are placed concentric circles made from light gage tin, edgewise, so as to fit between the center panel and the glass front of Section Number 1, thus giving a closed section between the center panel and glass front.

The tin rings and center panel board are painted a pebble white, so as to reflect light around corners and not cast any shadows.

Also in this center panel board are placed bases for electric light bulbs. There are two in the first planetary ring, four in the second, five in the third and seven in the fourth, also, there is one each behind the proton, neutron and element symbol rolls. These bulbs, 25 Watt, 110 Volt, and bases are placed in the closed space between

the center panel board and the transparent surface of Section Number 1.

In order to have movable electrons to show their number in each planetary ring, we placed a plunger type arrangement, constructed with a round rubber disc and a small gage rod with a loop on the outer end of rod for a handle. This rod is about 6" long. The rod is run through the back of the box and center panel board.

These electrons, of course, are lined up with the transparent rings of Section Number 1. On the ends of the rods, inside of the box, are placed the rubber disc which serve as electrons. By this arrangement one is able to add or subtract electrons as desired. There are two electrons in the first ring, eight in the second ring, eighteen in the third ring and thirty-two in the fourth ring.

The nucleus of the atom is shown by a portion inside of the first planetary ring, measuring 6" x 4". It is constructed of tin, as are the closed rings. Over the face of this section and right close to the glass of Section Number 1, are placed two rolls of paper which are controlled by reels. On these rolls are printed numbers of protons and neutrons within the nucleus. By this arrangement the rolls can be turned to any number, depending what element is under discussion.

As previously mentioned in this article, near the top of the instrument, just above the planetary rings is placed another roll on which is printed the symbols of the elements. This roll is also controlled by reels which allow one to turn to any element needed for class discussion.

To take a specific illustration, in the case of Fluorine, the atomic number of 9 indicates the presence of 9 protons, which would be shown by turning the top roll, in the center of the instrument, to the number 9. The atomic weight is 19, so that the number of neutrons must be 19 minus 9, or 10, which will be shown on the other roll in the center of the instrument. Then in the planetary rings we would push forward 9 rods, or electrons, so they would show on the transparent circles on the glass of Section Number 1, and in this specific case we would have two electrons in the first planetary ring and seven in the second planetary ring.

Now with this picture before a class where 9 represents 9 protons each with one unit of atomic weight and 1 charge, and 10 represents 10 neutrons each with one unit of atomic weight and no charge and 9 electrons showing on the planetary rings, one would be able to discuss valences, positive or negative, transferring and sharing of electrons, the Periodic Law, alpha and beta particles or isotopes and the packing effect of ions and its characteristics.

In conclusion, with the ever-increasing problems dealing with isotopes and mass spectra, et cetera, we are confronted with the problem of putting this material across to students in Chemistry and by the use of the Atom Model, by turning center reels with the proton and neutron numbers and by adding electrons as desired, one can set up any combination desired, thus discussing any and all phases of the atom and its present characteristics.

The author wishes to express his gratitude to Dr. E. M. Jones, Professor of Chemistry, Adrian College, Adrian, Michigan, for his helpful suggestions in regard to subject matter and construction of the Atom Model.

Carl Van Valkenburg
Morenci, Michigan.

Editorials and Educational News

MINUTES OF THE THIRTEENTH ANNUAL MEETING OF THE NATIONAL ASSOCIATION FOR RESEARCH IN SCIENCE TEACHING

HOTEL JEFFERSON, ST. LOUIS, MISSOURI, FEBRUARY 25, 1940

The meeting was called to order by the President, Otis W. Caldwell, with the following members in attendance:

P. M. Bail	Florence Billig
John Mayfield	Jennie Hall
J. S. Richardson	Gerald Craig
C. M. Pruitt	A. N. Zechiel
W. C. Croxton	F. C. Jean
H. A. Webb	H. E. Brown
Edith Selbing	Victor Noll
E. S. Obourn	Ralph C. Bedell
Otis W. Caldwell	Ralph K. Watkins
Anita Layton Conrad	G. P. Cahoon
Ira Davis	Phillip Johnson
Earl R. Glenn	George C. Wood
W. R. Teeters	Archer W. Hurd
M. L. Robertson	Robert J. Havighurst
F. D. Curtis	

The President's address to the Association was directed to the subject "Some Factors in Freedom for Research." This paper will be published in an early issue of SCIENCE EDUCATION.

The following report of the Secretary was next made:

The minutes of the proceedings and the transactions of the National Association for Research in Science Teachings at the last annual meeting held at Hotel Allerton, Cleveland, Ohio, February, 1939, together with the minutes of the annual meeting of the Executive Committee held at Hotel Pennsylvania, New York City, April 1st, 1939, have been distributed to the membership and have been published in SCIENCE EDUCATION, the official journal, as prescribed in the by-laws of the Association. This constitutes a report of the transactions carried on by your officers and Executive Committee during the current year.

COMMITTEES

The persons appointed to membership on Association committees were notified and any proposals of the Executive Committee were transmitted to the respective chairmen.

During the year the newly appointed Coordinating Committee has been at work formulating plans and organizing the membership into working committees in accordance with the report of the Policies Committee presented at the Cleveland meeting. A more detailed report of the work of this committee will be presented later at this meeting.

The Nominating Committee appointed by the President was as follows: S. Ralph Powers, *Chairman*, V. H. Noll, Ira C. Davis.

The report of the committee will be made later at this meeting.

The Secretary has been in communication with the chairman of each of the Association committees to determine if sufficient progress has been made to warrant a report at this meeting. Committees that wished to report will be called later.

MEMBERSHIP

During the year one resignation from the Association has been received. There are at present sixty-eight paid memberships, three life memberships, and three persons from whom dues have not been collected for 1939. The following new members have been duly elected:

Darrell Barnard, New York University, New York.
Clark W. Horton, Dartmouth University, Hanover, N. H.
H. Emmett Brown, Lincoln School, New York City.
N. E. Bingham, Lincoln School, New York City.
E. A. Waters, Ohio State Demonstration School, Columbus, Ohio.
Shailer A. Peterson, University High School, Minneapolis, Minn.
Karl F. Oerlein, State Teachers College, California, Pennsylvania.
Charles A. Gramet, Franklin K. Lane High School, Brooklyn, N. Y.
J. S. Richardson, Miami University, Oxford, Ohio.
W. R. Teeters, St. Louis, Missouri.
Dr. Edna Bailey, University of California, Berkeley, California.

The Secretary will present the applications of seven persons to the Executive Comimttee at its meeting tomorrow evening.

It was moved, seconded and passed that the report be accepted as read.

TREASURER'S REPORT

Receipts

Cash on hand March 1, 1939....	$51.81	
Dues from 68 members at $5.00..	340.00	
Interest from Savings Account..	12.04	
Sale of reprints.....	1.00	
Transfer from Savings Account	50.00	
Total.....	$454.85	
On deposit in Savings Account (less interest).....	744.91	
Total received		$1,199.76

Expenditures		
Printing programs	$18.25	
Duplicating report at Cleveland meeting	3.41	
Share of joint meeting with NCES at Cleveland	12.50	
Expenses of Association representative to the Cleveland meeting of the NEA Science Committee	62.09	
Science Education for reprints	63.91	
Science Education for reprints of minutes	11.63	
Science Education for 71 subscriptions at $2.50	77.50	
Expenses of representative to Chicago meeting of NEA Science Committee	32.00	
To check exchange	2.24	
V. A. Noll for postage	4.26	
To checking account for carrying charge	2.00	
		$389.79
Balance		$809.97
Deposit in Savings Account	$756.95	
In Checking Account	53.02	
		$809.97

It was moved, seconded and passed that the report be accepted as presented.

In the absence of Mr. Powers, Chairman of the Nominating Committee, Mr. Ira C. Davis made the following report:

For *President,* Harry A. Carpenter.
For *Vice-President,* G. P. Cahoon.
For *Secretary-Treasurer,* E. S. Obourn.
Member of Executive Committee, Otis W. Caldwell.
Member of Executive Committee, Florence G. Billig.

Nominations from the floor were called. It was moved and seconded that the report of the Nominating Committee be accepted. A short discussion followed, in which Mr. Webb spoke to the point of moving officers through in orderly succession. The motion to accept the report of the Nominating Committee was adopted and the Secretary was instructed to cast a unanimous ballot for the election.

The report of the committee to define "Research" was next called. The *Chairman,* F. D. Curtis, responded with the following report:

"In order to be classed as a research investigation a reported study must satisfy the criteria in one of two categories (a) the experimental and statistical studies and (b) the analytical and non-statistical studies.

Experimental studies are characterized by the following steps of technique:

1. A carefully and specifically defined and delimited problem.
2. An exhaustive examination of the literature appertaining to the problem.
3. The collection of data and their treatment by appropriate statistical techniques.
4. A statement of the conclusions which seem justified by the findings.

Analytical studies are characterized by the following steps of technique:

1. A carefully and specifically defined and delimited problem.
2. An exhaustive examination tf the literature appertaining to the problem.
3. A technique appropriate to the problem and also one that provides defensible means by which the validity and the reliability of analysis may be determined and maintained.
4. A statement of the conclusions that seem justified by the findings.

It is obvious that these two types of research are not mutually exclusive in all respects. Analysis often enters into studies that are primarily statistical; such elementary phases of statistics as numerical tabulations and computations of percentages or correlations may appropriately be a part of the technique of an analytical study.

An analysis, however, which presents only the results of the investigator's judgment unchecked by the judgments of others applying the sole technique and criteria, is not, according to this report, a research investigation."

In the discussion that followed, Mr. Glenn pointed out that this report should be placed in the official minutes to protect the organization and also to serve as a partial guide for judging the competency of persons proposed for membership in the organization. Mr. Brown suggested that the Committee should add several brief examples of research of different types to its report. Mr. Bedell suggested that the report might be published in a prominent place in SCIENCE EDUCATION and that criticisms be requested. He further pointed out the importance of this definition as a guide to those training graduate students. Mr. Zechiel questioned the applicability of the types of research defined by the committee to areas such as were defined in "Science in General Education." His fear

dealt with the application of statistical research to these areas. Mr. Curtis showed that the second type of research as defined by the committee, applied to studies in the areas mentioned by Mr. Zechiel. Dr. Craig pointed out that there was an increasing growth in the validation of research techniques useful in the more general areas. He suggested anecdotal records as an example of one of these techniques.

There was a motion to accept the report as a progress report and to continue the committee. The motion was seconded and passed.

Mr. Webb next presented the following report as the Association representative to the American Science Teachers Association, meeting held at Columbus, Ohio, December 27–28, 1939.

PROGRAM OF MEETING

Board of Directors—Wednesday, December 27, 6:30 P.M. Room 1337, Deshler-Wallick Hotel, Dinner and Conference.

Morning Session, Thursday, December 28, 9:30 A.M. Hall of Mirrors, Deshler-Wallick Hotel.

Presiding—W. L. Eikenberry, State Teachers College, Trenton, N. J.

9:30–10:15. 1. *The Contribution of Father Nieuwland to Synthetic Rubber,** Tho. Midgley, Jr., Chairman of the Board of Directors of the American Chemical Society, Worthington, Ohio.

10:20–11:05. 2. *The Anti-Scorbutic Vitamin,* Chas. Glen King, Professor of Chemistry, University of Pittsburgh, Pittsburgh, Pa.

11:10–12:00. 3. *A History of Science in Mural Painting,* Robert Lovell Black, Instructor of Biology, Emmerich Manual Training High School, Indianapolis, Ind. (Fifty-two scientists and a classification of living things. This five year project by Elmer E. Taflinger, mural painter, and Robert Lovell Black, science teacher, will be presented and briefly explained by Mr. Black.) The painting will be on exhibition in the meeting room.

Luncheon Meeting—Thursday, Dec. 28, 12:30 P.M. Hall of Mirrors, Deshler-Wallick Hotel.

Presiding—W. L. Eikenberry, President of the American Science Teachers Association.

Address—*The Role of Chance in Discovery*—Walter B. Cannon, President of the American Association for the Advancement of Science, Harvard University, Cambridge, Mass.

Afternoon Session—Thursday, Dec. 28, 2:00 P.M. Hall of Mirrors, Deshler-Wallick Hotel.

Presiding—Harry A. Cunningham, Kent State University, Kent, Ohio.

2:00–2:15. Announcements.

2:15–2:50. 1. *Outstanding Problems of Junior Academies and Possible Solutions,** Anne Augusta Schnieb, Professor of Education and Psychology, Eastern Kentucky Teachers College, Richmond, Ky.

2:55–3:25. 2. *Science in General Education at the College Level,* Lloyd W. Taylor, Professor of Physics, Oberlin College (Chairman of the A.A.A.S. Committee on Science in General Education).

3:30–4:00. 3. *Brooklyn Botanic Garden Cooperation with Public Schools,* C. Stuart Gager, Director, Brooklyn Botanic Garden, Brooklyn, N. Y.

4:00–5:00. Business Meeting, Reports of Committees, Election of Officers.

Board of Directors—Thursday, December 28, 7:00 P.M., Deshler-Wallick Hotel.

For your interest and convenience, your attention is called to the following lectures. All teachers attending the meetings of the A.S.T.A. are cordially invited to attend them:

A.A.A.S. MEETINGS

Wednesday, 8:15 P.M., Memorial Hall. *The Public Relations of Science,* retiring presidential address, Dr. Wesley C. Mitchell, Columbia University.

Thursday, 8:15 P.M., Memorial Hall. *The Future of Man as an Inhabitant of the Earth,* Dr. Kirtley F. Mather, Harvard University. Address sponsored by the Society of the Sigma Xi.

Friday, 4:30 P.M., Chapel in the University Bldg., Ohio State University. *Science, War and Reconstruction,* Dr. Julian Huxley, England.

Friday, 8:15 P.M., Memorial Hall. *Science and Literature,* Dean Marjorie Hope Nicolson, Smith College. Address sponsored by the Phi Beta Kappa.

Note: Registration offices and exhibits housed in the Civic Auditorium.

NATIONAL ASSOCIATION OF BIOLOGY TEACHERS

Friday, December 29, Room 100, University School Building. Sessions at 9:30 A.M. and 2:00 P.M. Dinner and Presidential Address, 6:30 P.M., Pomerent Hall, University of Ohio Campus. Complete program can be secured from P. K. Hondek, Secretary, Robinson, Ill.

AMERICAN NATURE STUDY SOCIETY

Thursday joint meeting with A.S.T.A., Friday and Saturday. For particulars write to Nellie F. Matlock, 5540 Pershing Ave., St. Louis, Mo.

AMERICAN ASSOCIATION OF PHYSICS TEACHERS

Wednesday A.M. and P.M., December 27; Thursday A.M., December 28. All sessions in

* Exhibits: There will be an exhibit by the du Pont Company to be used in connection with Dr. Midgley's paper on synthetic rubber. Another exhibit will be presented in connection with the paper on Junior Academies.

Chemistry Building, Ohio State University. Friday afternoon and evening joint meeting with American Physical Society and Section B. For further details write to T. D. Cope, Secretary, University of Pennsylvania, Philadelphia, Pa.

LUNCHEON INVITATION

A special invitation to the A.S.T.A. luncheon is issued to members of the A.A.A.S., National Association of Biology Teachers, American Nature Study and American Association of Physics Teachers.

A most dramatic event took place at the Luncheon Meeting, December 28, when a large book of letters from friends was presented to Dr. Otis W. Caldwell. These were written in appreciation of his long service of science education, and were in recognition of his seventieth birthday. The presentation was made in an eloquent tribute by Dr. J. McKeen Cattell, and the response of Dr. Caldwell was heartfelt.

At the business meeting the following officers were elected for 1940:

President, Harry A. Cunningham, Kent State University, Kent, Ohio.
First Vice-President, Homer W. LeSourd, Milton Academy, Milton, Mass.
Second Vice-President, Ralph K. Watkins, School of Education, University of Missouri, Columbia, Mo.
Secretary, Miss Deborah M. Russell, State Teachers College, Framingham, Mass.
Treasurer, Louis J. Mitchell, Dansville Central High School, Dansville, N. Y.

The report of the Constitution Revision Committee was not given in the absence of Mr. Powers, the chairman.

A report of the editor of SCIENCE EDUCATION, Mr. Pieper, was read by the Secretary. Mr. Pruitt, Business Manager of SCIENCE EDUCATION, reported that the financial condition of the journal was satisfactory and probably as good as it had been at any time.

Mr. Davis moved that the reports on SCIENCE EDUCATION be adopted and that a committee be appointed to form a resolution of appreciation to Mr. Pieper and to Mr. Pruitt for the excellent work which they have done on the magazine. Mr. Noll seconded the motion which was voted. Mr. Curtis was requested to present the resolutions at the Tuesday morning Business Meeting.

The following report was next presented by Mr. Noll, Chairman of the Coordinating Committee:

"Following the Cleveland meeting of the N.A.R.S.T., in 1939, a Coordinating Committee was appointed, consisting of Messrs. Craig, Curtis and Noll. The term of office was determined by lot, and the results were: Noll, one year; Curtis, two years; Craig, three years. Noll was elected chairman for the ensuing year.

In October, 1939, a questionnaire was sent to all the members of the Association inviting them to express their preferences as to the field of research in which they would care to work. A number of possible areas were suggested, and provision was made for additions. The returns of the questionnaire were quite satisfactory, although a substantial number indicated that they would not be able to attend the St. Louis meeting.

On the basis of these returns five working committees were organized to work in the areas of Curriculum, Methods, Evaluation, Teacher Training and Audio-Visual Materials, respectively. The membership was distributed to these five committees in accordance with individual preferences primarily; but also with a view to expected attendance at the St. Louis meeting, and a proper balance in size of committees. Each member was notified by mail of his appointment to a committee.

One member of each committee was selected as temporary chairman. This person was invited to accept this responsibility, and all agreed to do so. Each temporary chairman was mailed a list of the members of his committee.

The Coordinating Committee attempted to organize the Association Committees in such a way that there would be no delay in the short time available at St. Louis in getting the committees to work. It was suggested to the temporary chairmen that they get in touch with members of their respective committees and make any preliminary arrangements they deemed necessary.

The committees met for the first time on Monday morning, February 26, in St. Louis, and proceeded to elect a chairman and a secretary. Following this they outlined a program of work for the coming year.

The committees met again on Thursday morning, February 27, and the members of the Science Committees of the National Education Association were invited to meet with our committees at this time. Plans were completed for the year's work, and reports were made. Because of small attendance, the Committee on Audio-Visual Aids did not meet. However, the Coordinating Committee feels that this phase of the work should not be neglected.

The Coordinating Committee met in St. Louis and elected Mr. Curtis as Chairman for the coming year."

E. S. OBOURN,
Secretary.

EXECUTIVE COMMITTEE MEETING

HOTEL MILNER, ST. LOUIS, MO.,
FEBRUARY 26, 1940

The meeting of the Executive Committee was called following the program of Monday afternoon. The following members were present: Otis W. Caldwell, G. P. Cahoon, Florence G. Billig, E. S. Obourn.

The following business was conducted:

The Publications Committee consisting of E. D. Heiss, Chairman, R. J. Havighurst and John C. Hollinger was continued. The Secretary was instructed to so notify them.

R. J. Havighurst was elected for a term of three years on the Coordinating Committee to serve with F. D. Curtis and G. R. Craig.

G. P. Cahoon was voted as the Association representative and delegate to the American Science Teachers Association.

The Secretary, E. S. Obourn, was continued as the Association representative to the stockholders of Science Education, Inc.

The Secretary, E. S. Obourn, was continued as the Association representative on the National Committee on Science Teaching.

Otis W. Caldwell was voted Chairman of the Constitution Revision Committee. He was instructed to confer with S. R. Powers, the retiring Chairman of that committee to see what progress had been made in certain amendments to the constitution.

The Secretary was instructed to communicate with Ralph E. Horton and inquire if the Committee to Cooperate with the College Entrance Examination Board should be further continued.

G. P. Cahoon raised the question of the time of meetings of the Association. H. Emmett Brown was made Chairman of a committee to investigate the best time of meeting. The other appointments were S. R. Powers, Florence G. Billig, Harry A. Carpenter and E. S. Obourn.

The Secretary was requested to instruct the chairmen of former Association committees that unless some reason for continuance was proposed the committees were officially dismissed with appreciation.

The Secretary was instructed to prepare a mimeographed edition of an Association Directory. Mr. Caldwell offered to have it mimeographed.

Action was taken on the following applications for membership:

Nathan A. Neal	Joe Young West
W. A. Kilgore	Lon E. Edwards
Harold H. Metcalf	Robert Carlton
James C. Adell	Forest Olin Capps
Arthur O. Baker	Ronald Slay

There being no further business the meeting was adjourned.

Respectfully submitted,
ELLSWORTH S. OBOURN,
Secretary.

BUSINESS MEETING

HOTEL MILNER, ST. LOUIS, MO.,
FEBRUARY 27, 1940

The meeting was called to order with Otis W. Caldwell presiding. The report of the N.A.R.S.T. representative on the N.E.A. Science Committee was given by the Secretary.

In this report a summary of the organization, plans, point of view and deliberations was presented. The work of the various sub-committees was summarized briefly and reports of certain ones were passed out. The sub-committees of the N.E.A. Science Committee and their respective Chairmen are as follows:

Philosophy and Frame of Reference: Nathan A. Neal, James Ford Rhodes High School, Cleveland, Ohio.

Functional Outcomes, Social and Personal Needs: W. C. Croxton, State Teachers College, St. Cloud, Minn.

Materials for Science Teaching: E. S. Obourn, John Burroughs School, Clayton, Mo.

Committee on Evaluation: Carleton E. Preston, University of North Carolina, Chapel Hill, N. C.

Committee on Administration: Ira C. Davis, University of Wisconsin, Madison, Wis.

A new committee on Procedures was proposed at the last meeting and is now being formed.

Any persons interested in the work of

these committees are asked to write to the Chairmen for reports.

Mr. Preston and Mr. Phillip Johnson commented briefly on the work of the N.E.A. Science Committee. Mr. Will Burnett of Teachers College, Columbia University, presented a detailed report of the work of Teacher Training Committee. This material is available if you will write to Mr. Burnett.

An interesting discussion followed.

The Secretary presented a summary of the deliberations of the Executive Committee at its Monday afternoon meeting.

The Committee appointed at the Sunday evening meeting, prepared an expression of appreciation to Mr. Pieper and Mr. Pruitt for their excellent work on SCIENCE EDUCATION. This was read by the Secretary. It was moved and seconded that the resolution be adopted.

The Secretary was instructed to see that these resolutions be sent.

Mr. Hurd raised the question of funds available for the work of the Association Committees. The Secretary requested that except for small expenditures for postage and mimeographing, a budget be prepared and sent to the Secretary for the reaction of the Executive Committee.

Following are the reports submitted by the chairmen of some of the Association committees:

The report of the Evaluation Committee was presented by Mr. Bedell as follows:

Evaluation represents a basic area of science education in which the membership of the N.A.R.S.T. can be of material assistance to all teachers and research workers in science teaching. The Association's activities in this area should recognize the work being done by other organizations, and so far as possible our efforts should be directed toward evaluation activities not being attempted by others or toward an improved refinement of the accomplishments of others. While your committee recognizes the financial limitations under which work must be accomplished, it also is aware of the tremendous resources of ideas and experience within the N.A.R.S.T. membership. We, therefore, invite the cooperation of all members as well as nonmembers in the successful completion of the following projects:

1. Summarizing the progress and accomplishment reports of the several groups now attacking the problem of evaluation in science education. It is hoped that these summaries will be of sufficient value to merit publication in SCIENCE EDUCATION so that everyone interested may be aware of the progress being made by others. Reports of any evaluation group of which you are a member will be welcomed by the Committee.

2. The preparation of lists of specific objectives which should be the outcomes of science understandings, skills, and attitudes. Your committee feels that the early publication of such a list would be of utmost worth to all those now engaged in evaluation. We hear much of scientific thinking and scientific attitudes; but the need now is for more specific things which characterize these important objectives. Noll's analysis of scientific attitudes and Tyler's analysis of scientific thinking represent steps in this direction. Such behaviors as inferring generalizations from specific facts, the identification of data which support a given generalization as compared with data which do not, the ability to hold a suspended judgment when data are insufficient, the willingness to determine experimentally conclusions which are not supported by evidence, illustrate some of the more specific aspects of scientific thinking and scientific attitudes. Your committee is desirous of having exhaustive lists of specific objectives which provide an analysis of all of the more general objectives commonly ascribed to science education. Suggested grade levels for which these specific objectives may be appropriate are important.

3. The preparation of test items appropriate for the measurement of various kinds of specific objectives. While paper-pencil items are of great importance, the word *test* is here used in the broader sense to denote various kinds of behavior as well. Pupil performances, both individual and group, laboratory situations, anecdotal behavior or any other kind of specific behavior which characterizes science learnings are significant tools for science evaluation. Grade levels for which the various test and behavior items may be appropriate are important.

4. The preparation of a list of evaluation instruments. Your committee has considered paper-pencil tests, anecdotal records, interviews, performances, and group projects. Suggestions on additional instruments and refinements of the above will be welcomed by your committee.

5. The preparation of a list of areas of science evaluation. Your committee has considered knowledge, skills, attitudes, study techniques, problem solving techniques, and social responsibilities. Suggestions on other areas are invited.

Your suggestions on any of the above points will determine the extent to which your committee can function adequately. All material sent in will be examined carefully, and full credit given for that which is used in the publications and reports of the committee. Those engaged in any kind of evaluation study are especially urged to

report the accomplishments being made. Address all correspondence which should have the attention of the entire committee to the secretary.

Your committee has had one meeting which was attended by Curtis, Brown, Hall, Craig, Preston, and Bedell. The chairman has discussed the problems of the committee with Dr. Tyler, who was unable to attend the meeting. The organization of the committee for the coming year is indicated below.

Carleton E. Preston, University of North Carolina, Chapel Hill, North Carolina.

Ralph W. Tyler, University of Chicago, Chicago, Illinois.

F. D. Curtis, University of Michigan, Ann Arbor, Michigan.

J. Darrel Barnard, New York University, 32 Washington Place, New York, N. Y.

Anna Gemmill, State Teachers College, Buffalo, New York.

H. Emmett Brown, Lincoln School, 425 West 123d Street, New York, N. Y.

Clark W. Horton, Dartmouth College, Hanover, New Hampshire.

Palmer O. Johnson, University of Minnesota, Minneapolis, Minnesota.

Gerald S. Craig, Teachers College, Columbia University, New York, N. Y.

Cyrus W. Barnes, New York University, 32 Washington Place, New York, N. Y.

Shailer A. Peterson, University of Minnesota, Minneapolis, Minnesota.

Jennie Hall, Board of Education, 305 City Hall, Minneapolis, Minnesota—Secretary.

Ralph Bedell, University of Nebraska, Lincoln, Nebraska—Chairman.

Mr. Hurd gave the following report for the Committee on Teacher Preparation:

The following committee members were present at the organization meeting held Monday, February 26, in the Peach Room, Hotel Milner, St. Louis, Mo.: Earl R. Glenn, J. S. Richardson, Hanor A. Webb, M. L. Robertson, and A. W. Hurd.

Mr. Hurd, the temporary chairman, was chosen as chairman for the coming year.

From 31 suggested research areas submitted to all committee members before the St. Louis meeting, the following received particular approval:

Nature of Teacher Education for Science Teachers.
Selection of Personnel for Prospective Science Teaching.
Induction of New Teachers in Science.
Placement of Science Teachers in Teaching Positions.
Institutional Follow-up of Science Teachers After Graduation.
Growth of Science Teachers During the Teaching Period.

Discussion led the committee to select as a promising field for research for the coming year at least the general area of selection of science teachers for preparation with emphasis upon the particular element or factors leading students in preparing institutions to choose the field of science as a special area in which to concentrate.

Plans were formulated to prepare questionnaire and interview forms to use in making a student survey in some selected institutions. After preliminary forms are submitted to all committee members, final forms are to be prepared and used to collect desirable data from both undergraduates and teaching graduates. Each cooperating committee member was to be encouraged to feel free to supplement the data in any manner which seemed feasible.

The committee decided to ask for an expense allowance from the Association treasury and to submit a synthesized report to all members well in advance of the next annual meeting of the Association, so as to make intelligent discussion possible at that time.

It was understood by the committee that, eventually, a combined committee report would be published in the Association Journal.

Phillip Johnson presented the following report for the Committee on Methods:

"The sub-committee on Methods was called to order by P. M. Bail, the temporary chairman. The following members were present: Bail, Cahoon, Jean, Johnson, Thiele and Wood. The group decided to discuss the general problem of methods before selecting a permanent chairman and secretary.

Aspects of methods which were discussed by the committee may be stated as follows:

a. How can we teach pupils to define problems?
b. How can we teach pupils to gather data?
c. How can we teach pupils to evaluate data and draw conclusions?
d. How can we teach pupils to work cooperatively in the solution of problems?
e. How can we teach pupils to apply what they learn?
f. How can we teach pupils to assume individual responsibility for learning?
g. How can we teach pupils to engage in community betterment projects?
h. How can the effectiveness of various methods be evaluated?
i. What should the sub-committee adopt as a frame of reference for their deliberations?

After considerable discussion it was decided that the sub-committee should initiate and carry through some type of service project which may not necessarily qualify for research. The material prepared should be representative of progressive practices which have been found to be effective. The contributions of the committee should be published as a small monograph. It was decided that each member of the sub-committee should contribute in writing as follows:

a. An expression of their point of view,
b. An example of their point of view, and

c. A list of sources relating to their point of view.

Near the close of the meeting time, the group elected P. G. Johnson as Chairman and G. P. Cahoon as Secretary."

As the Committee on Materials did not meet, in the absence of its Chairman, Mr. Carpenter, no report was presented.

A report was presented for the Curriculum Committee by Mr. Mayfield, in the absence of the Chairman, Mr. Zechiel.

No report was received from Mr. Zechiel. Mr. Curtis discussed the danger of overlapping of the Association Committees with the N.E.A. Science Committees and suggested that one way to prevent this was perhaps to remember that the N.A.R.S.T. is essentially a research organization and that it is not our function to attempt to do all of the things that the N.E.A. Science Committee should do.

There being no further business the meeting was adjourned.

Respectfully submitted,

ELLSWORTH S. OBOURN,

Secretary.

New Publications

FRASER, CHELSEA. *The Story of Aircraft.* New York: Thomas Y. Crowell Company, 1939. 513 p. $2.50.

As man learned to travel over land and water, his eyes were often turned aloft, for he had a yearning to fly. Man's many attempts to conquer the air, and his subsequent conquests of it, are given in this book. Lighter-than-air and heavier-than-air flights are described in the two parts. Detailed accounts are given of attempts to use balloons from before the time of the Montgolfiers to present-day stratosphere flights. Likewise the first attempts to fly with airships are given, and traced to the modern dirigible.

In the latter half of the book, man's many attempts to make heavier-than-air machines fly are given. Parachutes, gliders, the Wrights' accomplishments, and the development of aircraft by different countries are given. The last chapter gives the author's views concerning future aircraft.

The book is especially well illustrated. There are many drawings illustrating early aircraft. Photographs are used to show modern airplanes.

Anyone interested in aviation will enjoy this comprehensive story of aircraft. It would be a worth-while addition to the school or home library. —Roy V. Maneval.

WELLS, A. LAURENCE. *The Microscope Made Easy.* New York: Frederick Warne and Company, Ltd., 1938. 182 p. $1.50.

All around us are multitudes of objects so small that they reveal their charms only to the microscopist. One is often baffled, bewildered, and made thoroughly disheartened by his first attempts at viewing objects under a microscope. The purpose of this book is to show that a great many simple though extremely interesting objects can be mounted easily and inexpensively. It is not too technical for secondary school students, yet it could be read with profit by anyone using a microscope.

The chapter headings well describe its contents: Introduction to Microscopy; Rough Mounting; Crystals; Pond Life Microscopy; Desmids, Diatoms and Foraminifera; Mounting Materials and Appliances; Mounting Methods; and Ringing, Finishing and Storying. The twelve pages of plates will aid the amateur in the identification of specimens. —Roy V. Maneval.

MELLANBY, HELEN and EASTHAM, L. E. S. *Animal Life in Fresh Water.* New York: Chemical Publishing Company of New York, Incorporated, 1938. 296 p. $3.50.

This work is a very elementary presentation of fresh water life written in a style that an inexperienced person can interpret, except possibly for the scientific names that are necessary in order to list the animals.

The book is not sufficiently complete to be extremely valuable as a reference book. It is reasonably well illustrated with line diagrams and the amateur who is interested in studying aquatic life would find it extremely interesting. —E. C. Harrah.

WRIGHT, W. D. *The Perception of Light.* New York: Chemical Publishing Company of New York, Incorporated, 1939. 100 p. $2.50.

A very readable text written in clear language. The illustrations are to the point, and one gains from reading this book an enlarged conception of the phenomena of vision.

This book should, in my opinion, fill a great need in physics and biology work. —E. C. Harrah.

WADDINGTON, C. H. *An Introduction to Modern Genetics.* New York: The Macmillan Company, 1939. 441 p. $4.00.

The author has prepared a rather complete work on heredity and has gone into great detail in explanation. For the individual who expects to specialize in genetics, this would appear to be an excellent book. It most certainly would serve most institutions as an excellent reference for general courses in genetics. It is too much material for a course such as is given in many institutions and appears to be extremely technical for immature students.

The paper on which this book is printed does not lend itself well to illustrations and the type on such paper is difficult to read.

The section on genetics and evolution is too limited to show fully the relationship that exists. —E. C. Harrah.

KERMACK, W. O. and EGGLETON, P. *The Stuff We're Made Of.* New York: Longmans, Green Company, 1938. 342 p. $3.20.

In this work the authors have chosen to present the method of the scientist in collecting and evaluating data in a manner that ordinary persons can interpret. Their object is undoubtedly an effort to help the layman to become a better citizen in that he can better interpret the phenomena among which he must live.

The data is arranged for a biologic chemist's point of view and is very easily read. The authors do not clutter their ideas with too many details so that the reader's attention is diverted for generalized ideas.

This book certainly would be valuable material for the beginner in science and also for supplementary reading in science survey courses. It

includes such items as "What is Truth," "Atomic and Molecular Structure," "Energy and Everyday Use," "Diet," "The Racket That Has Been Made Out of Knowledge of Vitamins," and "The Relation of Sex to Man's Living."

—E. C. Harrah.

Haas, Arthur E., and Freeman, Ira M. *Elementary Survey of Physics.* New York: E. P. Dutton and Company, 1938. 203 p. $1.50.

A good deal has been written in the past few years on the subject of survey courses in Physics and the Physical Sciences. There are as many different definitions of the survey course as there are authors for such books. Here is a further attempt to bring the subject of Physics down to a level which can be easily grasped by the non-technical student. The material is technically correct and is so treated as to be most easily understood. There is very little in the way of mathematics used in the book. Only the simplest arithmetic is used and then only when absolutely necessary. The explanations are clear and easily understood. The illustrations and diagrams are brief, to the point and easy to follow. There are no problems, questions or summaries at the ends of the chapters. This represents physics at its simplest. The subjects covered are the usual subjects found in all physics texts. They are: the mechanics of solids, liquids, gases, acoustics, general thermal principles, changes of state, ray optics, wave optics, spectroscopy, electricity, the nature of matter and, etc. There is an appendix in which the essential data and physical formulae may be found for the student who desires to use this material. It appears as though the authors have tried to stress the every day application of the principles of physics. These principles are as clearly stated as is possible. The use of this book would require a great deal of teaching on the part of the instructor and would allow him plenty of freedom to exercise his own ideas in presentation of material and of its demonstration. The place this book will occupy in the educational scheme is not clear but for a short and strictly non-technical course in physics, it should find a ready application as well as a reference for the more technical courses in physics.

—F. L. Herman.

Whitman, Armitage. *From Head to Foot.* New York: Farrar and Rinehart, Inc., 1939. 262 p. $2.50.

This book written by an orthopedic surgeon for the layman is full of helpful information. It is written in language that we can understand. Whether or not we have "been operated on" we have intense interest in what the skilled surgeon can do today. Dr. Whitman, besides giving good advice, tells of many experiences in hospital life. A few of the nineteen chapters are on these topics: posture, the foot, curvature of the spine, infantile paralysis, fractures, joint injuries, low back pains, social service, workmen's compensation, and operations.

—W.G.W.

Riesman, David. *Medicine in Modern Society.* Princeton: Princeton University Press, 1938. 226 p. $2.50.

Advance in civilization goes hand in hand with advance in medicine. This book tells in fifteen intensely important and interesting chapters, the history of medicine and gives a vivid picture of the present status of modern medicine. It is a book for all to read and enjoy.

—W.G.W.

Harpole, James. *Body Menders.* New York: Frederick A. Stokes Company, 1939. 296 p. $2.75.

Here are twenty breathless dramas selected from a surgeon's records. They depict the feelings of surgeon, nurse, and patient at the critical period during and after an operation. The thrilling stories of modern miracles and hair-line boundaries between life and death are true records from a great surgeon's experience. The book was first published in England as *The White-Coated Army.*

—W.G.W.

Little, Clarence Cook. *Civilization Against Cancer.* New York: Farrar and Rinehart, Inc., 1939. 150 p. $1.50.

Dr. Little, formerly President of the University of Michigan, and now engaged in cancer research at Jackson Memorial Laboratory, has taken time off to write this brief yet scientific volume on cancer control. In twelve chapters he discusses cancer recognition, the hunt for weapons, making cancer to order, knowledge of cancers, cancer inheritance, the fight to control cancer, and prospects in view toward this control.

The discussions are in interesting and easily-understood language, and give the layman an up-to-date background in this very important field of work. The intent, of course, is to solicit the aid of all people in this great campaign to eradicate cancer, one of the most prolific killers of mankind.

—A.W.H.

Young, George Allen. *How To Use Your Camera.* San Francisco: Camera Craft Publishing Company, 1939. 48 p. $0.25.

This is a brief, practical pamphlet on the use of the camera. It discusses such points as focusing, exposure, filters, composition, eliminating errors, outdoor portraits, candid pictures, action pictures, flowers, and animals. There are numerous photographs used for illustrative purposes.

—C.M.P.

INNESCOF, GEORGE. *The Secrets of Filters for Photography.* New York: The Galleon Publishers, 1939. 48 p.

This is an excellent, brief treatise on camera filters which will prove useful to those who know little or nothing about filters but are desirous of improving their ability to use filters correctly. The illustrated booklet discusses the nature of light, filters and films, correcting filters, control filters, when to use a filter, types of filters, and filter factors.

—C.M.P.

STEND, WILLIAM. *The Secrets of Snapshots Without Failures.* New York: Galleon Publishers, 1939. 46 p.

This is the second of the Photo Amateur Series. It discusses such topics as the time of day, the quality of light, point of view, selection of subject, proportion, moving objects, dimension, and so on. There are several illustrations to emphasize certain points.

—C.M.P.

GRAHAM, GORDON. *The Secrets of Speed Photography.* New York: Galleon Publishers, 1939. 48 p.

Speed and action photographs often bring much grief to the amateur. How to avoid certain pitfalls and improve present technique are described in this illustrated booklet. The topics are: equipment for speed photography, films for speed photography, candid action, reciprocal action, exposure for speed photography, and types of action subjects.

—C.M.P.

LEWIS, HARVEY. *The Secrets of Focus and Exposure.* New York: Galleon Publishers, 1939. 48 p.

This is a useful little pamphlet for the amateur user of the camera. It discusses the relation of the lens to focus, how to estimate focus, adjusting for distance, determining exposure, overexposure and underexposure, shots at night, shooting moving objects, and so on.

—C.M.P.

ODELL, CHARLES WALTERS. *The Secondary School.* Champaign: The Garrard Press, 1939. 606 p. $3.00.

This book, suitable for use as a textbook for an introductory, undergraduate college course in secondary education, is planned in six parts: (I) Foreign and American Systems of Secondary Education; (II) Our Secondary School Population; (III) The Secondary School Curriculum; (IV) The Secondary School Extra-Curriculum; (V) Articulation of the Secondary School With Other Schools and With Society; and (VI) The Secondary School Teaching Staff. Each part includes several chapters.

Ancient, medieval, English, French, German, Italian, Russian, Swedish, Norwegian, Danish, Canadian, Mexican, South American, Japanese, Chinese, and Australian secondary school systems are touched upon for the purpose of setting the stage for an extended discussion of our own secondary schools.

Characteristics of adolescents including individual differences are then discussed.

Curriculum objectives and construction are followed by descriptions and discussions of the varied divisions: English, foreign languages, mathematics, science, the social studies, the practical and fine arts; and health and physical education as found in our secondary schools.

Under extra-curriculum are discussed: objectives and organization, pupil self-government, clubs, athletic meets, social and recreational activities, school publications, and miscellaneous activities.

Articulation with elementary and higher education and with the community, and guidance constitutes Part V.

Qualifications, service conditions, attitudes, viewpoints, and miscellany are topics under teacher preparation.

The plan is quite complete and well arranged and the language of discussion straightforward, connected, and understandable. There are few tables or graphs. Each chapter is followed by a generous reference list.

—A.W.H.

GREGORY, TAPPAN. *Eyes in the Night.* New York: Thomas Y. Crowell Company, 1939. 243 p. $3.50.

A thirty-year hobby of photographing wild life at night is the background affording material for this book. In the detailed accounts of getting bait, setting traps and camera for the animals to take their own pictures, is woven a never failing thread of their intimate life habits. Many rodents, rabbits, bears, deer, foxes, coyotes, wolves, and mountain lions help take the interesting photographs which illustrate the stories so delightfully told by Mr. Gregory.

—W.G.W.

SEDGWICK, W. T., TYLER, R. W., AND BIGELOW, R. P. *A Short History of Science.* New York: The Macmillan Company, 1939. 512 p. $3.75.

To understand and appreciate the deeper meaning of science, it is always necessary to know the story of its development. More than twenty years have elapsed since the first edition, Sedgwick and Tyler's *Short History of Science* (Macmillan, 1917), was published. Dr. Sedgwick died some years after the first publication. To the surviving author fell the enormous task of giving to us the historical perspective of intervening years. The last chapter was completed when a sudden heart attack abruptly ended the work of Dr. Tyler leaving to the junior editor the onerous task of finishing the book. Like the earlier edition the book is the outgrowth of a course of

lectures given to undergraduates at the Massachusetts Institute of Technology.

The first eight chapters trace the development of science from earliest times to the Moors in Spain; from chapter nine through chapter seventeen, we have the story of the progress of science and the beginning of modern mathematical as well as the physical sciences of the various centuries. Appendix A briefly summarizes the inventions of the eighteenth and nineteenth centuries. Appendix B tabulates some important names and events with dates in the history of science and civilization. It is this grouping of events in the history of science and cilivization that makes the information more valuable. The book concludes with a list of books of general reference and biography as well as a list of source material. There are also references at the close of each chapter. The book is illustrated. It is not that the authors have condensed history and science into so small a volume that compels our admiration. What really commands our attention is that they have caught the remarkable spirit of men and events and portray them with extraordinary clearness bringing the older civilizations immeasurably closer to us both in time and spirit.

—Greta Oppe.

Adams, Frank Dawson. *The Birth and Development of the Geological Sciences.* Baltimore: Williams and Wilkins, 1938. 493 p. $5.00.

A belittling attitude is often expressed toward the early theories in a science which have by later research been proven in error. This is somewhat true of astrology and still more true of alchemy. Wonder is expressed that supposedly intelligent men could express such naive belief. These men, probably equal in intellectual ability to scientists of today, did not have the vast accumulation of experience now available. Scientists of today are also less constrained by the necessities of preconceived beliefs arising out of religion. Although geology has not a parallel term to the astrology of astronomy and the alchemy of chemistry it does have a comparable period during which much cogent reasoning was perhaps carried on but with erroneous results due as much to false assumptions and over use of analogy as to inconsistent theory. This book elaborates this period in a fascinating way. Very effective use is made of original source material. The author gives enough of the social history to enable the reader to see the relation of the growth of geological knowledge to the conditions which brought it about. After a thorough description of sources, various topics such as origin of stones, origin of metals and their ores, origin of mountains and other problems of geology are traced from the earliest theories. Chapter VIII discusses the Neptunian and Plutonian controversy and the rise from this of modern geology. Chapter XIII deals with quaint stories and beliefs.

—O. E. Underhill.

National Education Association. *Proceedings of the Seventy-Fifth Annual Meeting.* Washington, D. C.: National Education Association, 1939. 991 p.

The proceedings include papers (usually abstracted) which were presented at Cleveland and San Francisco and official records of the National Education Association for the school year 1938–9. For various reasons, not all papers are given. General sessions, morning assemblies, the vesper service, dinner meetings, and discussion groups are represented as well as departmental sessions. Departmental sessions include the national council, adult education, health and physical education, school administrators, teachers colleges, research, business education, classroom teachers, elementary and secondary school principals, home economics, kindergarten-primary education, lip reading, music education, deans of women, social studies council, administrative women, rural education, science instruction, secondary teachers, special education, supervisors and directors of instruction, visual instruction, and vocational education. A section on the world federation cruise is added. The last quarter of the volume is given over to association records and reports, which include minutes of official meetings, officers' reports, and about thirty committee report summaries.

—A.W.H.

The Proceedings of the Congress on Education for Democracy. *Education for Democracy.* New York: Bureau of Publications, Teachers College, Columbia University, 1939. 466 p. $2.50.

More than thirty addresses or summaries of addresses and reports of sixteen seminars are included in this book. The congress was held August 15, 16, 17, 1939, at Columbia University. Participating in it were more than 500 delegates from twenty-six prominent national lay organizations and some 300 or more educators from all sections of the country. More than 300 distinguished citizens of New York and vicinity in addition acted as sponsors.

The public addresses were given by eminent representatives from America and foreign countries on the following aspects of democracy: "Democracy and its Challenge"; "Democracy in Other Lands"; "The Contribution of Religion to Education for Democracy"; "Present Educational Opportunities for Rural Youth in a Democracy"; "The Contribution of Higher Education and Adult Education to Democracy"; "Democracy at Work"; and "Democracy Moves Forward."

The purpose of the Congress was to initiate a movement toward a better understanding among lay and educational groups on the questions of democratic life and education for this life. The future of America and the world is bound up with this clearer understanding. Discussion of the issues after the manner of democracy is an important method of attack toward the solution of the problems involved. The leaders of the

Congress give specific emphasis to the necessity of considering this Congress as a beginning only. They look forward to "next steps in education" and "next steps in cooperation."

It is impossible to summarize such a book as this briefly. The encouraging thing is that such a congress of eminent personalities on a democratic basis was assembled. The reviewer was struck with the reiterated stress on the underlying necessity for cultivation of a dominant democratic culture on a world-wide penetrating basis; the development of the "humane spirit" as a corner stone of this culture; the dangers of the "tyranny of the many" in a "mobocracy" which might enslave the great minds of the world; and the demand that education of the masses in an efficient, functional, and realistic manner is the only hope of democracy. Society itself must be fashioned by creative education which leads the lives of all people upward to higher levels of achievement. What is the most efficient form of social organization which will accomplish the clearly defined objectives which await mankind's desire? That is the goal of an enlightened education. Democracy is being weighed in the balance.

—A.W.H.

McGILL, MARTIN V., AND BRADBURY, G. M. *New Chemistry Guide and Laboratory Exercises.* Chicago: Lyons and Carnahan, 1939. 378 p. $1.00.

New Chemistry Guide is a laboratory manual, a study guide, and review program all in one. It is definitely in unit form, fourteen in number with some fifty problems to be studied. The book is quite new in its approach and abounds with references to the use of chemistry in every day life. A highly welcome feature is the emphasis placed upon information gained in previous units making the study of chemistry more or less cumulative and continuous. This is admirably brought out in Unit 14, "Using useful compounds to review important principles." After carefully studying this unit and its fine purpose, one feels the urge to find a more suitable name for the unit than the one used in the table of contents. A stimulating feature is the use of pictures to introduce each unit in addition to the interesting previews.

—Greta Oppe.

HOWARD, RUSSELL S. *Units in Chemistry.* New York: Henry Holt, 1938. 834 p. $1.80.

This revised high school text in chemistry has been developed out of the work and experiences of a teacher in one of the township high schools in Illinois. There are eight major units in the content. These include changes in matter, solution and crystallization, general properties of gases, the atom and the molecule, ionization acids, bases and salts, nonmetals and their relatives, the metals and their compounds, and the nature of carbon compounds.

The method of development follows the "Morrisonian" interpretation of the teaching unit. For each unit there is a unit introduction, a statement of the "elements of the unit," an outline of the content of the unit, the presentation of the subject matter itself, a long list of review questions, a list of recitation topics, and a list of references.

The list of review questions includes a number of chemistry problems, but these are not separated from the review questions in the organization. These lists of review questions run from a hundred to over a hundred and fifty for particular units. The teacher may well question the soundness of such lengthy lists of review questions as a means to good learning on the part of the pupil.

There is a considerable appendix. The first part of the appendix includes many useful tables and teaching references. Other parts of the appendix appear to be mere afterthoughts.

High school teachers of chemistry should be familiar with this text. The order of units is somewhat unconventional and may possess considerable merit.

—R.K.W.

UNZICHER, SAMUEL P., AND GRUENBERG, BENJAMIN C. *Activities in General Science.* Yonkers: World Book Company, 1939. 202 p. $0.68.

This is a workbook to accompany the authors' textbook, *Science in Our Lives.* The 270 problems are student problems intended to guide the student in scientific doing and thinking. All sorts of problems are included to give training in various aspects of the scientific method. Problems range from the quite simple to the more complex. There are abundant, accurate illustrations and the experiments require simple materials and equipment.

Science teachers will find this a most useful workbook, adaptable for use with most any textbook and classroom situation. The problems are grouped around certain units of study.

—C.M.P.

GRUENBERG, BENJAMIN C., AND UNZICKER, SAMUEEL P. *Teachers Manual for Science in Our Lives.* Yonkers: World Book Co., 1939. 171 p. $0.80.

Most of the material of this manual is devoted to specific teaching aids to accompany units found in the author's textbook *Science In Our Lives.* These units are: (1) the fire around us, (2) water, (3) fire, (4) the earth in space, (5) controlling the world, (6) electricity, (7) being alive, and (8) grasping the world.

However, there is much valuable general material useful to all science teachers. These discussions center around the following topics: (1) on teaching science, (2) science pure and impure, (3) concerning questions and answers, (4) the placing of science in our lives, (5) organization of the textbook, and (6) classroom schedule and units of work.

Teachers using *Science In Our Lives* will find this manual especially useful.

—C.M.P.